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MONDAY—NOVEMBER 17

Welcoming Address

RICHARD ERVIN
Attorney-General, State of Florida, Tallahassee, Fla.

On behalf of the Florida State Board of Conservation, I wish to express my thanks for your kind invitation to make the address of welcome today. I am very happy to extend to all of you in behalf of the State of Florida a warm welcome to this fifth annual session of the Gulf and Caribbean Fisheries Institute. I am delighted to welcome representatives from Norway, Netherlands, Bermuda, Martinique, Cuba, Puerto Rico, the Bahamas, Surinam, Pakistan, Thailand, and the Barbados.

I also welcome legislators and state fisheries men from the Gulf states and the Atlantic states of this country. Those two regions demonstrate cooperation in the Atlantic States Marine Fisheries Commission, the Gulf States Marine Fisheries Commission, and the Southeastern Fisheries Assaciation, all of which are represented here. Universities from Florida to Texas and from New York to Florida have representatives here. I am pleased to welcome the many people from Washington, representing the United States Fish and Wildlife Service, the Department of Agriculture and the National Fisheries Institute.

In mentioning those that are contributing to the success of this Institute, I feel that I must pay special tribute to Dr. F. G. Walton Smith and his staff in the Marine Laboratory of the University of Miami. We are justly proud of this Laboratory, of its staff, and their work. Because of its strategic geographical location, and the outstanding work performed here, under the able direction of Dr. Smith, it has become the world's foremost tropical marine research laboratory.

The Gulf and Caribbean Fisheries Institute is the product of cooperative effort among many groups representing many different ideas and aims. We have here cooperation among the scientists, the government administrators, and the fishing industry.

This is an institute that seeks to bind together the fishermen, the fish dealers, the fish processors, fishery biologists, technologists, economists, and the conservation administrators of the fisheries, all pooling their efforts to solve the mysteries of the deep and moving sea. In this manner it is believed that the several groups of persons interested in the fisheries from the several different points of view, may have an opportunity of broadening their horizons and seeing their problems in a truer perspective against the background of fisheries as a whole. The Institute further seeks to provide a forum for the exchange of information and the discussion of problems concerning the fisheries of the Caribbean, South Atlantic and Gulf of Mexico. In many ways, these fisheries differ widely from those of the northeastern and western fishing centers of the United States.

Though science has explored all corners of the earth and much of the sky, it has been able to learn only a few of the ocean's dark secrets. Vast areas of

marine science are still blank, puzzling mysteries. In an impoverished, hungry world, the ocean holds bright promises of food, medicine, oil and metals, but it still challenges the scientists to make these benefits available to mankind

Only in the last few years have the marine biologists and oceanographers had laboratories adequate to study and solve underwater problems affecting man's welfare. Most of the world's important marine laboratories, because of their locations, can investigate only the conditions of the cold northern seas.

Here is the Gulf and Caribbean, and beneath the warm tropic ocean exists a world of wonders about which so little is known. Here is the last frontier of marine science, and we have unusual advantages in attempting to cross this last frontier. Off this southern coast is a colossal storehouse of marine life. In these warm seas grow the coral. Here the Gulf stream forms. Great new knowledge in oceanography and the marine sciences is being won from these warm, teeming waters where marine life is active year round.

Cooperation between states is one device that can be successfully used to solve these mutual problems. You have used this device in the establishment of the Gulf States Marine Fisheries Commission, the Atlantic States Marine Fisheries Commission, the Oil Compact Commission, which brings together states, and Gulf and Caribbean Fisheries Institute, which brings together not only states but nations. You have used this method of gaining cooperation and breaking down barriers ably and thoughtfully. It is therefore, a pleasure to meet with you and observe this fine example of state governments and industry in action. It is pleasing to see how representatives of an industry and representatives of government can and do get along together in solving our fishery problems.

I welcome you with the feeling that this is indeed the locale of the conscience of all citizens who are truly interesetd in the nation's fisheries. I feel that here we find the balance between expediency, whether economic or political, and long range social benefits.

In this forum dedicated to conservation, you and I both hope to speak to a public which is wider than that in actual attendance here today.

The prevention of waste of our natural resources is the key to the economic well being of our nation. The wealth of any nation is not measured by her bank balances. The wealth of America is not represented by her bank balances or the shares of stock traded on the stock exchanges. America's wealth lies in her rich soil, waterways, cattle; her iron and steel; her oil and gas; her copper, coal and other minerals; her railroads and ships; her factories and the goods and products which can be produced and made availible for human comfort and a continuing higher standard of living; her fisheries that provide recreation for the sportsman, a livelihood for the fisherman and food for our people.

These are the things that constitute our real worth. Our future security and prosperity are dependent upon how we conserve them and how efficiently we use them.

With the assistance of the conservative bodies of the states and nations that are represented here together with industry and the understanding and cooperation of our fellow citizens, I am sure that the future of the fisheries will not be a static or liquidating operation but that you will continue to demonstrate that the cooperation and work that you started here five years ago when this Institute was formed will never come to an end but that it will continue to grow and improve day after day.

Opening Address

J. L. Baughman
Las Olas Oceanographic Foundation, Rockport, Texas.

All of you have heard the story of the passenger pigeon and its destruction by the market hunter. It is an interesting story, much used, the only trouble being that "it ain't necessarily so".

In 1830 Audubon saw a flock of these birds that took three days to pass. When such flocks alighted trees broke under their weight and even mass slaughter by hunters apparently made not the slightest impression on their numbers. Indeed, he says, "It was a scene of so much uproar and confusion that I found it quite useless to speak, or even to shout. The reports of the guns were seldom heard, and I was made aware of the firing only by seeing the shooters reloading". After describing the scene of carnage, he goes on to say that it might be thought "that such havoc would put an end to the species. But I have satisfied myself, by long observation, that nothing but the gradual diminution of our forests can accomplish their decrease".

Fifty years later, the forests had been so reduced that, while pigeons were still common, there was only one major nesting place left for the remnants of the flocks. Here, at Petoskie, Michigan, in 1881, they arrived earlier than usual in uncounted multitudes, and covered an area much greater than ordinary with their nests. In April, after nests were built, and the eggs laid a terrific sleet storm struck one day, just at dusk. The birds rose in clouds, with a thunder of wings, and disappeared into the fog over Lake Michigan. A few days later, when hunters arrived, the shore was strewn for miles with dead birds, and the stench was so great in the forest that comprised the nesting ground that no one cared to enter.

The combination of the gradual destruction of their habitat by the axe and plow, and this final blow by Nature was too much. Within 20 years there were only 50 birds left of the once great flocks, and in 1914 the last passenger pigeon died in the Cincinnati Zoo.

When I was a boy, we moved from this country to Canada, 70 miles from a railroad. The country was just as the Indians and buffalo had left it. There were buffalo trails everywhere, grass-grown but discernable, and I could ride for a hundred miles in any direction, without encountering a barbed wire fence Wherever I rode the prairies were dotted with sloughs, or ponds, and on those sloughs and on the big lake a couple of miles west of the house, there were ducks by the millions. Mallards and pintails, teal and shovellers, squattered and quacked, and dozed in the sun, waking up occasionally to feed.

The hens nested, not at the edges of the sloughs, but back on the prairie, sometimes 500 or 600 yards from the water. When the youngsters were hatched, they grew up on the sloughs, safe from predators and in the fall moved to the big lake where they formed rafts, sometimes several acres in extent, before migrating southward.

With the coming of man and his plow all this was changed. The first year the prairie was plowed, water remained in the sloughs until July or August, as it had always done. The second year, because much of the run-off sank into the plowed land, instead of draining, water in the sloughs did not last as long.

The third year there was still less water and by the fourth or fifth year the slough bottoms could be plowed.

First the nesting grounds were destroyed, and then those safe harbors, the sloughs, in which the ducklings could grow to maturity without being exposed to predatory attacks. The result is that the ducks, despite better conservation practices in recent years, have not, and never will, come back to their former numbers, because never again will they have as much room favorable for breeding. Three million square miles or more of their choicest habitat were destroyed and, combined with an increase in human population and hunting pressure, the handicap is too great.

It is not always the most apparent thing that destroys our fish and game, but all too often sportsmen and conservation clubs do not see this.

The thing that happened to the passenger pigeon and the ducks is happening to many other species. Land that once supported quail has none, areas where there were once wild turkeys know them no more, antelope range no longer carries antelope, and big horn country has few or no big horns. Of course, hunting pressure and game hogs have had their parts in all of it, but the reason that most places do not have the game or fish that once lived there is because the habitat has been radically changed by cultivation, or grazing, or lumbering, and no longer is fitted for the support of wildlife.

A concrete example of this is our coastal waters. In fresh water biology, it has long been accepted as a truism, because proven so many times, that silt coming into the rivers of the country in enormous and uncontrolled quantities is the greatest and most serious factor operating to destroy the fisheries; that pollution resulting from municipal and industrial wastes is next in importance; that silt and pollution each augment the damage done by the other; and that elimination (by these things) of the shore zone so necessary for spawning grounds young fishes, and the production of fish food, is also a serious factor in limiting both fish and shellfish.

These facts are not generally recognized in connection with marine organisms, yet they comprise probably the greatest single underlying cause of the deterioration of our coastal waters.

When I began, first many years ago, to study marine fisheries, I was inclined to believe that it was possible to increase greatly the production through changes in legislation. I have not altogether departed from this view, although I have, with few exceptions, come to regard any such measures as stop-gaps of somewhat doubtful value.

Upon going further and further into the matter, I became convinced that it was not legislation alone that was to blame, nor overfishing, but that there were underlying causes that must be determined and remedied before we could do any great and lasting good. As knowledge of the coast was gained, this opinion was confirmed: more and more did it become apparent that the alteration of our fisheries was due to alteration of the habitat where the marine organisms lived, aggravated by the fact the human population of the coast is now many times that of only a few years ago, of course resulting in increased fishing pressure.

Those of you who were here two years ago may remember that we discussed the effect of apparatus upon the fisheries. I believe I am correct in stating that we eventually concluded that there is no apparatus or combination of apparatus

now known to man that can exterminate a stock of marine fishes. Oysters, of course, are a different proposition, as they are sedentary animals. However, even with them, certain economic facts apply. When the law of diminishing returns sets in, fishermen will cease to fish for them, just as they will for fish and shrimp.

Taking this into consideration, and adding to it the tremendous resiliency of the various stocks of marine animals, it becomes apparent that fish, shrimp, and oysters can withstand sustained fishing pressure without suffering any permanent damage. To understand then, why they were not withstanding it became necessary to search for the added and hidden factor that had unbalanced the scales.

In our area, along the Texas coast, it became apparent almost immediately that this factor was the physical deterioration of our bays. While conditions in the Galveston and Nueces Bay areas were greatly aggravated by the enormous masses of municipal and industrial pollution being poured into the waters of those localities, the thing that was most seriously affecting all the bays of the coast was the tremendous deposition of silt emanating from various sources. This was brought about, generally, by a larger run-off of rainwater and increasingly severe flood conditions in our rivers, the result of forest denudation, poor agricultural practices, and over-grazing. As a consequence, I feel that the lumberman on the Trinity, the farmer on the sources of the Colorado, and the rancher at the head of the Nueces are as much or more to blame for the destruction of our marine resources as are any of our present fishing practices.

Fish are selective organizations. At one place it is possible to haul a seine over hard sand mixed with a little shell and take speckled trout, redfish, and pompano. A similar haul, within a comparatively short distance, made over mud bottom, will produce catfish, sand trout, and perch. Oysters require a hard bottom to live and propagate. Failing this, they have little chance for survival.

Where, prior to the widespread settling of the land with its resulting increase in run off and erosion, we had great stretches of sand and shell bottoms suitable for the maximum production of seafoods, we now have increasingly smaller bottoms of the type necessary to the fish and shellfish that we like to eat, and increasingly large areas suitable for the production only of the so-called trash fish. It would be possible to elaborate greatly upon this, to give facts, figures, and statistics, almost without end; but for the purposes of this discussion it would be pointless to go into these things here. I merely endeavored to point out a thing that is all too often lost sight of by many of the laymen, and some of the conservationists who should know better.

Overfishing is not the reason for every case of depletion; legislation restricting the operations of any one group of fishermen may be only a stop-gap; legislation of any kind may be worse than useless if it offers no remedy for true cause of the damage, which is all too often unknown. Restriction of commercial fishing, or of sports fishing, while it may redistribute the fish, making it possible for one group to catch more than another or both, still has not cured the primary ill, the destruction of our coastal waters.

MONDAY—NOVEMBER 17

Chairman—Wayne M. Waller, National Fisheries Institute
Washington, D.C.

The Outlook for the Menhaden Industry of the Atlantic Coast

Exteen Corbett
Nassau Fertilizer and Oil Co., Fernandina Beach, Fla.

The Menhaden industry is one of America's oldest, yet very little was known about it until the last decade. Its origin dates back to the days of the American Indian. The word "menhaden" itself originated with the Indians and meant "to fertilize" or "make things grow." In the early days, the Indians planted a menhaden under each hill of corn to make the good earth produce better. The early Colonists were quick to realize the benefit of this fertilizer and adopted its use as early as 1621. Later many farmers of Connecticut, Rhode Island and along Long Island Sound spread the raw fish over their farm to condition the soil.

It has been reported that the first serious effort to separate oil from menhaden was made by Barker and Tillman in 1811 at Black Point Wharf, Portsmouth, R. I. The fish were boiled in large iron pots until the flesh tissues were broken down. This mass of material was weighted down by means of rocks on boards. When the oil came to the surface it was either skimmed or drained off and barrelled. This was the crude beginning of the menhaden oil industry.

From 1865 to 1870, factories were developed in Maine where steam was used for cooking and power for pressing. By 1878 as many as 60 factories had been built and were operating in New York and New England, processing annually around 500 million fish. Factories then sprang up southward in Delaware, New Jersey, Chesapeake Bay Area, the Carolinas and later in Florida. Only in the last decade have plants been established in the Gulf of Mexico area.

From 1870 to 1875, the bulk of the menhaden were concentrated off the coast of New England. Today menhaden are rarely found in these waters, although they came back in sizeable schools in 1949, as well as in the summer of 1952. The majority of these fish are found south of the northern tip of Long Island—that is, off the coast of New York, New Jersey, Delaware, Chesapeake Bay Area, the Carolinas and Florida. The Gulf menhaden is a different sub-species from the East Coast variety.

It was during World War II, when there was a great shortage of protein that the menhaden industry came to the forefront. Many manufacturers of poultry feed were seeking new sources of protein, and they tried fish meal. To their amazement, they found that they were not only getting a good natural "animal" protein, but were getting remarkable results from some unknown growth factor. This growth factor, which became known as APF or "Animal Protein Factor", was concentrated, and in a short time a substance, which was named vitamin B_{12}, was isolated. However, later research proved vitamin B_{12} was not the sole active substance and there still remains to be solved the identities of all the growth factors in menhaden fish meal which so accelerate chicken growth of poultry and improve the hatchability of eggs.

Unlike the situation in the sardine fishery, there has been an almost annual upward trend in the catch of menhaden, with no sign of decline in abundance. Usually, where there is a small catch in one area, there will be a good catch in another area that will continue to push the catch upward.

This does not mean that the industry may not fail in the future, but it appears that the large catches are so far not affecting the abundance of fish. The industry would certainly like to know more about the biology of this fish so that necessary conservation methods could be adopted, if they proved necessary. Operations today should not be allowed to cause the extinction of this fish tomorrow.

Publicity about the menhaden through radio broadcasts, popular magazine articles, and the excellent and ever-popular Fish and Wildlife Service film "The Story of Menhaden" have done much to enlighten the public about this industry. Today the menhaden is landed in larger quantities than any other in the U. S. and Alaska. The total catch of menhaden last year was one billion one hundred and four million lbs. The value of the fishmeal and oil exceeded $23,500,000.

The pork packers are proud of the fact that they can get everything out of a pig but the squeal. If a fish had a squeal, modern menhaden processors would get that too. The fish are unloaded from boats with large suction pumps. Water is removed by passing the fish through a large rotary screen or over a shaker. The catch is either weighed or measured. The menhaden pass now by conveyor to the cooker or to storage bins, called "raw boxes", for later transfer to the cookers as needed. The cooker is a long narrow chamber filled with steam jets and it is here the fish tissue are broken down by the steam. In the steam cookers the fish move by means of a screw conveyor. Huge screw presses separate the press liquor from the press cake. Most plants allow the press liquor to pass over shaker screens to remove the "fines," or suspended particles. This also can be done by running through a decanter. The oil is separated from the press water by centrifuging. The "stick water" (liquor after oil and fines are removed) is concentrated to a 50 per cent solid. This soluble solution is known as "menhaden condensed fish solubles", and is used primarily in chicken feeds. It contains important amounts of the water soluble vitamins.

The press cake is carried from presses by means of conveyors to a large rotary steam dryers or direct heat dryers. Here the press cake is dried from approximately 50 per cent moisture to about 9 or 10 per cent. The dry scrap is now cooled and "cured" by dropping it from overhead conveyors and by turning it with small bulldozers. This further lowers the moisture content of the scrap to approximately 8 per cent. The scrap is now ground into fishmeal, or it may be bagged as fish scrap. Special sewing machines and electric conveyors and power lifts are used in the sacking and loading operations.

Even though many menhaden plants have adopted modern methods there are still many phases of the menhaden industry today that require additional study and research. Some of these problems are the following.

The abundance of fish fluctuates greatly from year to year in each locality. The most modern equipment cannot produce fish when there are none in the area. From 1943 to 1945, menhaden were found in large schools off Florida; these years of abundance were followed by poor years from 1946 to 1950. Then during the past two seasons, 1951 and 1952 menhaden have again been appearing in larger quantities. It is impossible to predict what the catch will

be off the Florida coast for the next season. Some companies have plants in several areas and move their boats to the area where fish are abundant. However, this is expensive and the fish may disappear again before good catches can be made. Information is obviously needed on methods of predicting abundance and on the behavior of the menhaden.

The high cost and shortage of labor has handicapped many menhaden plants and boat owners. Many former fishermen are taking steady jobs on shore where pay checks are more. To offset this some companies have installed suction pumps aboard the menhaden vessel for loading the fish aboard the ship from the nets. This operation, in addition to reducing the number of fishermen, enables the crew to make more sets, since fish can be loaded faster. In addition it reduces wear on the nets. More technological research is necessary to improve gear and fishing methods to reduce further the labor requirements on the vessels.

Lack of knowledge of how to preserve the fish until the boat arrives at the plant results in losses, especially to the plant owners located in warm climates. Stale or decomposed fish yield poorer quality products. Chemicals have been tried but to date none has proven successful. Much research is required in this question.

A thorough study of the food of the menhaden would be of tremendous value. The relationship of food to oil production has received no attention from scientists. Herring fishermen recognize that the food of the herring directly effects the quantity and quality of herring oil and this matter requires study in the menhaden fishery.

The past few years has seen the use of fishmeal change from that of a fertilizer to almost exclusively that of a high protein supplement in animal and poultry feeds. Expansion and modernization of plants is going forward in an effort to increase their capacity, and as a result the menhaden catch for the past four years has exceeded one billion pounds. Despite this importance little is known about the biology of the menhaden. Certainly knowledge of this fish's range, its spawning, factors effecting its abundance and its migrations are desirable.

Research has a big job to do for the menhaden industry,and it should start soon.

An Outline of the Manhaden Industry

Robert G. Lowe, Jr.

Wallace Menhaden Products, Inc., Morehead City, N. C.

Considering that it is the most prolific fish in the waters of all the seas, and that it supports the biggest fishery in the United States in point of tonnage landed, the menhaden, or pogy, is as little known as a fish could be. Last year one billion one hundred million pounds of menhaden were caught in the nets of the purse-seiners. This figure is more than twice that of the next most numerous species of fish landed and accounts for about one quarter of all fish brought to the dock.

Of his love life and spawning habits we know nothing. From "whence he cometh and wither he goest" is likewise a mystery. We know that he has been recognized in seven different species, namely, *Brevoortia tyrannus B. brevicaudata, B. patronus, B. pectinata, B. aurea, B. smithi and B. gunteri.*

B. tyrannus is the most common species in the Atlantic Coastal waters and *B. patronus* is by far the most abundant in the Gulf of Mexico.

Menhaden vary in length from about 3 to 18 inches and in weight from an ounce or two to over a pound. The larger species are much less numerous than those running from 5 to 10 inches in length.

In physical appearance the menhaden has the characteristics typical of a small shad or herring. Just behind each side of the head there is a black spot on most species. The species that abounds in the Gulf is usually marked along the fins and the tails with a yellowish tint that sometimes blends into a greenish hue.

The history of the menhaden fishery goes back beyond the earliest colonial days of America when the Indians caught them and sowed one to each hill of corn for fertilizer. Its very name is derived from the Indian "Munnawhataug", which is roughly translated to mean "a thing which fertilizes".

The main reason for the early settlers' development of the menhaden fishery was for the extraction of oil. Although today only a negligible portion of the menhaden catch finds its way into fertilizers, this was the prime use of the solid end product for many years and is, no doubt, responsible for the erroneous but prevalent impression today that menhaden, or pogy, is used almost exclusively for fertilizers.

Menhaden is also known variously as pogy, shad, fatback, bunker, alewife, bugfish, hardhead, chebog, mossbunker, baitfish and many other aliases in different sections of the coastal areas.

The menhaden occurs in all of the coastal waters of the eastern and Gulf areas in this country with the possible exception of the Florida peninsula. Menhaden were first processed in the Maine and Rhode Island areas. The operations were not on a regular basis and the equipment, both for fishing and reduction, was of the crudest form. Later, along in the 1850's in Connecticut and Long Island, refinements in the process were made. The 1870's showed the first indication of the general trend of the menhaden industry southward. There has been only one major appearance of this fish north of Cape Cod since 1880. This was in Maine in 1950 and was of short duration. Today Long Island marks the northern boundary of commercial fishing for the menhaden. Although a few are caught in fish traps to the northward, they do not exist any more in commercial quantities in that area. In the south, the first commercial pogy fishing in North Carolina started at the beginning of the present century, and slowly moved southward until now there are plants in the Fernandina area on Florida's east coast.

Almost completely unexploited until the past several years, the Gulf coast now has active plants from Florida to Texas. Louisiana has four, two located at Empire and two at Cameron. Mississippi also has four, while Texas has two and one is located on the Florida Gulf coast.

Fishing for menhaden in the Gulf of Mexico is active from April through October, with the larger runs of fish with the highest oil content expected during the months of June, July and August. The season observed in the New Jersey-Deleware area, the Chesapeake Bay area and to the southward to Florida starts the latter part of May and can be expected to last through September into October. The exception in this area is the central North Carolina coast,

where the fleet based in the Morehead City-Beaufort area usually expect large runs of the largest menhaden from October to January.

There are more than 30 menhaden reduction plants in operation in this country. There is no accurate estimate as to the number of boats engaged in this trade, as these purse seiners are shifted from plant to plant according to the season of the year and the run of the fish.

Menhaden run in schools consisting of several thousand individuals up to huge bodies of fish covering acres of the sea and containing millions of fish. Normally these fish swim at the surface or near it. At the surface they are distinguishable by a dark brown br reddish coloration on the water. When just below the surface they are located by "whipping" or "playing" of the fish. Another telltale sign is the sight of large numbers of gulls and pelicans feeding in a given area. In recent years electronic "fishfinders" have been developed to locate schools of fish not otherwise discernable. These instruments, called fathometers or echosounders, utilize the principles of electronics used in sonar, a development stimulated by submarine hunting during World War II. Another most effective means of spotting schools of menhaden is by use of airplanes. Both the airplane and the fishing boats are equipped with radiotelephone equipment. By this communication the pilot can accurately direct the boats to the schools of fish.

When a school is located, the crew, numbering 20 or more, takes to the two steel purse boats towed behind the mother boat. One is in the charge of the captain and the other in the charge of the mate. Each boat carries one-half of several hundred yards of purse seine.

Meanwhile a small skiff, known as the striker-boat, has marked the location of the head of the school. The purse boats move together to this point. The purse boats now separate and circle the school in opposite directions, paying off the net. When the school is circled the boats meet again and the net is "pursed" by drawing in the bottom with the purse line, hauled by a hand winch, until the fish are in a bag. Then, the crews in the purse boats take in net by hand and often to the cadence of ancient chanteys until the school is a compact mass of fish.

The big boat then comes up and the purse boats are made fast to her side to form a triangle enclosing the fish. The fish are then put into the hold of the mother boat by bailing (or "brailing", as the operation is technically known), or by means of a hydraulic conveyor. Each set will contain from a few thousand to several thousand fish. This procedure is repeated until the big boat is loaded with half million fish or more, or until darkness or the weather prevents further activity.

When the fish are brought to the factory they are sold by the thousand, each member of the crew receiving shares in accordance with his particular job. The arbitrary measure of 1,000 fish is that number which will fill 22,000 cubic inches, or 96 gallons. By actual count there are considerably more than a thousand fish in this space. This historic measure is constant throughout the industry however. It is considered that each 1,000 fish will weigh 666 $\frac{2}{3}$ pounds, so, for conversion purposes it is figured that 3,000 fish equals one ton.

Fish are usually landed within 10 to 15 hours of the time they are caught. They are processed within the next twelve hours.

Boats were formerly unloaded by means of bucket elevators. Almost all un-

loading at the present is done by means of large pumps, either piston or centrifugal, which actually serve as hydraulic conveyors.

The fish pass from the measuring hopper into a storage compartment called the "raw box". From here the fish are drawn into cookers. These long, narrow chambers are equipped with a line of steam jets over which the fish are moved by means of a screw conveyor or revolving paddles. A steam pressure of about 10 pounds is maintained in the cookers. The fat must be separated from the tissue without overheating since excess heat is believed to damage the protein values of the meat and to interfere with the remainder of the reduction process.

Solids and liquors from the cooker pass into screw presses which squeeze out the "press liquor" and leave the "press cake". The press cake is carried into either flame or steam tubular dryers which reduce the moisture content to the vicinity of 10 per cent. The scrap, when discharged from the dryer, is placed in piles and turned several times to eliminate the residual moisture and latent heat. Fish scrap is ground to produce fish meal.

The press liquor is either passed through centrifuges or run into large settling tanks to separate the oil from the residue, known as stickwater, after having been passed over vibrating screens to remove any large particles of solid matter that may be present. The fish oil is drawn off into storage and shipped in tank car lots for use in industry in its crude form or to processors who treat it for specialized uses.

The stickwater is freed of its residual oil and much of the suspended protein by either centrifuging or by gravity separation. It is then concentrated approximately ten times, generally by means of triple effect vacuum evaporators. The 50 per cent solid syrup that results from this process is called condensed menhaden fish solubles. This is usually acidified to stabilize it in storage, and shipped in tank car lots.

We see then, that the menhaden yields three products: (1) fish meal or scrap, (2) fish oil, and (3) condensed fish solubles.

The meal is valued as a feed ingredient for poultry, swine and other domestic animals for its high protein value, and its well balanced content of amino acids, its vitamin content and its content of trace minerals.

Menhaden fish solubles are used primarily as a feed ingredient. Its value lies in its wealth of vitamins, particularly the essential B-complex, and the unknown growth factors that are recognized as essential to the well-being and proper development of all animals including humans. This plentiful supply and even balance of almost all of the vitamins, plus the ability of various types of bacteria to thrive in this culture, indicates that solubles will become an excellent fertilizer. The menhaden feed on plankton and is thus an efficient machine for reclaiming the chemical nutrient wealth washed to sea each year from our soil.

It has been conclusively demonstrated that the catching of menhaden does not interfere with the catching of food fish nor sport fish. Only in rare instances have other species of fish been found in pogy nets.

It should be now evident that this little known pelagic creature, the menhaden, which exists in such large numbers, and about which so little is generally known, finds its place, in one way or another, into some phase of our lives every day.

Some Technological Aspects of Menhaden Products

T. M. Miller

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Broadly speaking, the technology of menhaden covers every phase of the reduction industry. It enters into methods of extending the life of nets, in preserving the catch at sea and in studying the details of the process of reducing the fish into useful products. It is used in measuring the extent of raw material losses and in studying menhaden fish meal, condensed solubles and fish oil. In addition there is the constant hope of extending the number of basic products derived from menhaden as well as increasing the range and extent of utilization. Obviously it is impossible to cover all of this ground in one paper. The Wallace Menhaden Products Laboratory has issued the following mimeographed reports which may be obtained upon request:

1. A review of the research activities of Wallace Menhaden Products Inc.
2. A technical bulletin on menhaden fish scrap and meal.
3. A technical bulletin on condensed menhaden fish solubles.
4. A technical bulletin on menhaden fish oil.

Technical work specifically on the subject of menhaden has been somewhat sparse. The reduction process is basically a simple one, involving cooking the fish, and pressing, drying, centrifuging and evaporating the product. These steps closely resemble well-known chemical engineering unit processes.

Some of the preservation problems encountered in the menhaden industry have been studied on other species of fish by scientists working in countries as widely separated as Canada, Norway and South Africa. Sometimes baffling plant problems are encountered, particularly in producing condensed fish solubles, but it is surprising how a few well known laboratory tests can clarify a situation and point the way towards a solution.. Attempts to find new uses for the raw material reveal a surprising similarity between projected uses and what has already been done in utilizing casein, meat products, soybean, and vegetable drying and semi-drying oils. Thus the chief job of a menhaden technologist is to resolve the problems into basic elements and then apply much of what is already known.

Six items from the files of the Wallace Menhaden plant are cited to help illustrate the nature variety of the problems:

1. Raw material losses are a constant concern in menhaden reduction plants. Even before the fish reach the raw box, there is a big loss resulting from the method of flooding the holds of the boats and then pumping out the fish. The water is separated from the fish before reaching the raw box and the oil and protein loss is often surprisingly large. To estimate this loss freshly caught fish were scrubbed with distilled water and the amount of protein removed in relation to the weight of the fish was determined. This was equivalent to one ton of fish meal for every million menhaden caught. Since this is the best rather than the worst conditions the normal loss is high.
2. The moisture content of menhaden fish scrap and meal is an important factor in shipping since consumers unanimously prefer protein to water. It was disturbing, therefore, when one of the Wallace Menhaden plants

began to encounter damp fish scrap. The scrap was leaving the steam dryer in good condition and from there was being picked up by a pneumatic conveyor and blown for a distance of 300 feet to the scrap shed. At this point it was being ground and bagged, having cooled on the way. The trouble seemed unpredictable. At times it happened on damp days but not always. The grinder operator supplied the necessary clue. He had observed that it usually occurred on especially cold days. Temperature and humidity tests showed conclusively what was happening. Moisture laden air from the plant was cooling on the way to the scrap shed and releasing its water to the scrap. A tinsmith with 12 feet of pipe eliminated the problem by making possible the use of air from the outside.

3. Some pressing problems have been encountered in the production of condenced fish solubles. Operators in other companies have reported difficulties with small fish, involving "scaling" of the tubes, involving deposition of hard material. Fortunately, small fish came late in the season. There had been several months without a serious scaling condition, but when it developed we had to shut down for the tedious job of boring out tubes. The scale was found to be largely compounds of calcium, magnesium and phosphorus apparently brought about by the high proportion of bones of the small fish. A change of operating procedure measurably reduced the problem for the rest of the season.
There are times when stick water will foam and thereby reduce the speed of evaporation. One morning this situation developed in our evaporator and almost stopped the production of solubles. Fortunately, there was a tell-tale sign of what had happened. The condensate from the evaporating stick water had turned blue, indicative that the copper tubes were being attacked by a substance which did not belong in the system. It turned out to be ammonia. Adjustment of pH with enough acid to tie up the free ammonia eliminated the foaming, and evaporation resumed at normal speed.

4. In menhaden reduction plants it is common for certain components of the fish to tend to separate in the course of the process. The Wallace Menhaden Products Laboratory has studied this problem. The separation occurs as a result of differences in specific gravity and some potentially valuable materials are concentrated in this way. One substance that tends to keep part of the oil tied up in the stick water, turns out to be an excellent emulsifying agent and could be isolated for such a use. At another point there is one which shows promise as a starting material in the synthesis of caffeine.

5. The differences in specific gravity of some components of menhaden led to a process for which a patent has been applied. In some respects it is similar to flotation methods used in the mining industry, by which one material is floated in a liquid while the other sinks to the bottom, because of differences in unit weight. In a like manner, parts of menhaden can be fractionated by mixing the dried meal in a liquid of suitable specific gravity which permits one portion to float and another to sink. In its broadest application it appears that the low specific gravity fractions are highly nutritious as protein concentrates and may, in addition, be capable of competing with casein in the field of plastics, adhesives, paper coating compounds, in textiles, etc. Along more academic

lines, in applying the flotation principle in the laboratory we may have found a useful way of evaluating our products, and perhaps of predicting the quality of proteins in fish meals. Much work remains to be done on this particular point.

6. In 1864 Dana reported to the Maine Board of Agriculture, that cattle are an effective means of converting objectionable fish residues to a readily useable form of manure. He was ingenious in recognizing a double objective of supplying nutrient and of obtaining a valuable fertilizer. Fortunately, there are now more economical ways of processing and using raw fish, but Mr. Dana's point was well taken. The use of natural processes continues to offer vast possibilities. Menhaden materials are excellent nutrients and organisms have been grown upon them to increase their feeding value. It is believed that mushrooms can be nurtured in menhaden stick water. It is known that is can be used to improve range land. It is hoped to work out nutrients suitable for bacteriological processes resulting in important chemicals and pharmaceuticals. In fact, the range of possibilities seems bounded only by the limits of imagination.

Tomorrow's By-Products

Wayne M. Waller
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Any discussion of the "by-products" of the menhaden industry would be brief since the industry does not currently produce anything that is strictly a by-product. All of its products are primary. However, because fish meal, solubles and body oils are so classified by other producers as well as the U.S. Fish and Wildlife Service, this term will be used in the present paper.

The basic products of the menhaden industry have been the same for 100 years, with the exception of the stickwater. This long record of stability would seem to indicate that no abrupt changes should be expected. However, we may be approaching just such a time.

In almost every field of science, engineering and industry research and developmental activity is at a high pitch. Since we have an economy that is responsive to new products and methods, as the findings of the various groups are made known to each other, the effects are far reaching and rapid. Because of this ferment in the scientific world it is important that every manufacturer be alert to trends and that he actively plan to ajust his process to take advantage of new discoveries.

Here are a few examples of recent developments that may have an effect on the menhaden industry, adverse or beneficial.

1. Agriculture provides the largest market for menhaden products, and agriculture is being revolutionized. By the addition of about one twentieth of one per cent of a chemical soil conditioner the tilth of some soils is semi-permanently improved to the extent of increasing crop yields 20 to 80 per cent.
2. The Carnegie Institution is engaged in research on a process for the

cultivation of algae as a source of proteins and oils. One method which seems to have promise is to expose the algae to sunlight in plastic bags through which water and fertilizers are circulated. This project is in its infancy, but it indicates the possibility of producing huge quantities of protein and fat by a factory process rather than by planting a crop, feeding an animal or operating a fishery.

3. Man can now make rain. This suggests the possibility of being able to change the climate of a region.

4. There is now a successful formula for synthetic sow's milk, which is making practical the operation of pig hatcheries. One potential of this system is to make possible three litters per year per sow instead of two. Incidentally, it is said that 5 to 10 per cent of fish solubles are a necessary ingredient in these synthetic pig starters.

5. By the use of chemical growth regulators, such as 2-4-D, the life processes of plants can be altered to produce more desirable results. About one millionth of an ounce applied to a small part of a plant will make that part grow faster than the untreated part, about 2,000 times this amount will stimulate the plant to burn up its food supply and die in 1 to 3 weeks. The use of chemical growth stimulators may also produce some spectacular results in the fields of poultry and animal husbandry.

6. It is estimated that the total damage to agriculture by insects, fungi, plant and animal diseases and weed infestation was equal to about 42 per cent of the value of the 1951 production. More efficient and versatile drugs, insecticides, fungicides and hormones are bringing these factors under control. More than 6,500 airplanes are now in use seeding, dusting, spraying, fertilizing and defoliating field crops.
Several of these developments are yet in an early stage. However, the accumulated effect on agricultural productive efficiency has amounted to a reduction of 10 per cent in man hour requirements since 1941.

7. The six billion dollar investment in the field of atomic energy is commencing to provide new knowledge in nuclear physics, chemistry, biology and medicine. Hundreds of scientists have been trained under the fellowship programs to pursue methods of applying this knowledge to the general welfare. More than 300 patents have been made available for licensing to industry. The radioactive elements are providing a clearer view of what happens in living processes. In the past five years radio phosphorus has provided more information about phosphate fertilizers than had been learned from the previous 50 years of study. Probably the most spectacular boost to the economy by atomic science is its promise to reduce greatly costs of heat, light, manufacturing and transportation by providing power at a fraction of present cost.

It is too early to predict the impact of these new technological advances on he menhaden industry. There is no immediate cause for alarm and probably he long-range effects will be beneficial. The developments are to encourage a loser observation of them on the part of menhaden products so that they may e better enabled to adapt themselves to the changing pattern.

There is a great deal of reason for optimism to be derived from an examination of what is taking place in the fishing industry, and of the fundamental conomics on which it is based. We are commencing to develop methods for

farming the sea. In Scotland, fiords have been successfully fertilized, greatly increasing the yield of fish. In San Francisco Bay, in conjunction with the evaporation of sea water for salt, algae are being grown at one stage in the basins. Copepods are then introduced to feed on the algae and later harvested for protein. Preliminary investigations hint that we may learn how to attract fish up from the depths or herd them by means of a controlled electronic technique, and further that this method may permit selectivity as to size and, consequently, species. Here is great promise of a cost-reduction that would make the menhaden industry an even more competitive producer of nutrients and oil. Underwater photography, including television, is rapidly adding to our knowledge of marine life.

Recent preliminary work indicates that fish oils may be more valuable as a source of energy in poultry rations than for some of its present uses. Hence, the future of the industry appears to be even more allied to our food industry than in the past and the market potential in the food field is very bright.

Our population is increasing at the rate of 4 people per minute, or 6,000 per day. By 1975 this will amount to 38 million more people at the table, equal to the present population of all the southern states of Virginia, North and South Carolina, Georgia, Florida, Kentucky, Tennessee, Alabama, Mississippi, Louisiana, Arkansas, Oklahoma and Kansas.

To feed this population as we did in 1950 we will have to increase milk production by an amount equal to the total present output of Wisconsin, Michigan and New York; the additional pork that will be needed is equal to the present tonnage from Nebraska and Iowa; the extra beef will be equal to the present output of Minnesota, Texas, and Oklahoma; lamb and mutton equivalent to Nevada, Utah, Montana and Wyoming; and for eggs an amount equal to the present capacities of California, Kansas, Missouri, Pennsylvania and Illinois.

The basis of all vegetable and plant life on this planet is photosynthesis, which is the ability of green plants, in the presence of sunlight and chlorophyll, to manufacture complex organic chemicals from carbon dioxide, water and other simple materials. Man cannot yet duplicate this process. The source of energy for this process is solar radiation and 70 per cent of the earth's solar energy goes into the oceans. It has been estimated that the oceans contain about one million times as much carbon as our atmosphere and that the average carbon fixed per year per square kilometer of ocean surface is estimated to be 375 tons as compared to 130 tons per square kilometer for land surfaces. The photosynthetic activity of the ocean is estimated to be ten times that of all the plants growing on land surfaces. Millions of acres of our submerged coastal areas are covered with dense submarine forests of seaweed, and these marine plants are unusually rich in the trace elements so deficient in most land plants. Obviously the oceans are low-cost "conversion vats" of enormous capacity. The fishing industry has a head start in the development of these great resources and should be able to produce useful commodities that will be competitive to other sources far into the future.

As to what tomorrow's products will be we cannot be certain, but we do know they will have to be useful to our economy and at practical costs. The menhaden industry has a great stake in the success of the future development of marine products. Because of its seasonal nature, it is a logical group to de-

vote time to the necessary research and, considering the talent and imagination with which it is endowed, there is little doubt that it will help pioneer in this last great frontier.

Finally some remarks should be made about today's products. Competition from synthetics is very real and tends to lower the relative market prices of oil, meal and solubles. It is, therefore, highly important that this industry continue to increase its degree of quality control so its products will be less vulnerable to substitutes.

In the two years the writer has worked as a representative of the menhaden industry, few complaints have been received concerning its products or services. However, there is one characteristic of the industry that does not please the average customer. This is that most of the meal, scrap and solubles must be sold almost as soon as they are produced. Unfortunately, the season of the highest production does not correspond with the season of highest consumption and, as a result, most of the tonnage is sold in a buyer's market during which most producers are distress sellers. It is not known what this costs the industry, but it would not be surprising to learn that its mounted to as much as $10 per ton on meal and scrap and one half to one per cent per pound on solubles. No solution is apparent now, but when it is found it will pay dividends in higher average sales income, greater customer satisfaction and a reduced vulnerability to competition.

"Quality Control" in the Fisheries

KARL ENVOLDSEN
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Quality has come a long way in the last 50 years. Fifty years ago fish canning was a rather crude operation. Cans were hand-made and hand-sealed and there was only a small pack as a consequence. Sale of even this small pack was difficult, partly because of low quality. Cans of tuna would sometimes explode on the grocer's shelf and spray the ceiling and shelves with spoiled fish, resulting in a very angry groceman. Tuna canning was unsuccessful for a long time, until through experimentation and general cleaning up of plants it became a profitable industry. Canners began to learn about sanitation and its effects upon the keeping quality of foods.

By now the Food and Drug Administration had come into being. Public confidence in the Administration was bolstered by backing given it by the "Good Housekeeping," which had become a household by-word for guidance in quality in foods.

Then, as now, the public knew that "Food and Drug" was taking care of food quality.

All of this leads to the conclusion that enforced quality control is what brought quality along so fast during the past half century. But the prohibition amendment of the twenties, taught that the Federal Government was not so infallible as had been supposed. Doubts were created as to the necessity of quality control.

A "What is good enough for Father, is good enough for me," attitude was prevalent. Laziness also has a deal to do with poor quality, and some of the

failure to progress as far as we should have in quality control can be attributed to this.

In 1928 the writer heard of a stupendous purchase made by O. L. Carr of Mid Central Fish Company in Kansas City. He had bought a whole carload of "Nordic" fillets of frozen haddock. It was amazing to think that anyone would buy a whole carload in the central part of the United States, especially in Kansas. But it sold, as did subsequent car-loads, and today the big distributors in the central part of the United States buy millions of pounds of frozen fish. They only buy them because the quality of the fish is so much better than it was under the old "iced-fresh" conditions. Despite this improvement, however, much of the fish in the country is not frozen soon enough after coming out of the water. The public gradually is learning this and is demanding good quality. Public opinion may be the main element in forcing quality control. Is the fish industry going to pick up the challenge and go forward from here faster than it has in the past? Because of the things we know today about quality (thanks to the research being done by the various universities and by government and commercial laboratories and companies throughout the world) the time is right. The pressure of consumers make it certain that an enforced quality control will be imposed upon the fish industry unless the industry controls itself.

Recently Dr. John Ward from England, visited our plant. He said, "Mr. Envoldsen, this is the finest plant I have ever been in, but I want to tell you that I am not very pleased with the majority of the fish plants and other food canning plants I have seen in your country. In England, food plants must have nothing in them but stainless steel. We really go in for some quality over there. We have made great advances in recent years, but the greatest improvements came after we were forced to make them."

The writer is chairman of the Quality Committee for the National Fisheries Institute. The idea of control has been rejected and the group is called the "Quality Committee".

The committee functions at present by exposing to the packers themselves and to their competitors the faults of the industry, through cuttings and analyses, and then to let them go home to clean up their own plants.

In the writer's opinion the Shrimp Association of the Americas may be putting the cart before the horse. While they are suggesting to their members improvements in sanitation in their plants, they are also spending a great deal of effort on advertising. To advertise something that isn't the best of quality is rather a waste of effort. Sales will probably show improvement for a while, because when the people do not know what a quality should be, they accept anything. After a while they begin to find out that some qualities are better than others, and then the packers of poor quality products will get hurt. In regard to the quality control work of the Shrimp Association of the Americas has had its greatest effects in plants in Mexico.

Voluntary government inspection that was proposed several years ago by Food & Drug has pretty much failed, because it was not set up by the industry, but by people who do not understand the meaning of practical quality controls in the shrimp industry. In our own plant, which we think is the finest fish plant in the world, we put out shrimp, on which the bacterial count on the finished product average less than 100 bacteria per gram. Yet that plant would not pass the rules set up in the voluntary inspection!

One factor which prevents the production of better quality fish or shrimp products is resistence from the fisherman and his union. It is almost impossible for any fish dealer to tell his fishermen to dump a load of fish that hasn't been properly handled. That could only be done with a strong organization and rigid quality control. It must be preceded by a great deal of research on the proper handling of fish and shrimp.

The work done by Mr. Punchochar and others of the Fish & Wildlife Service in the freezing of cod and haddock in the round at sea, has been very useful. The freezing of shrimp at sea has also shown how a high quality product can be handled. However, these advances are bound to come slowly and until the public has learned to differentiate between qualities and to pay more for fine quality, they will continue to be slow.

In the past half century there have been remarkable advancements in food quality and plant sanitation. But while the public still believes all foods to be adequately policed by the Food & Drug Administration advances cannot be made as fast as they should. Research and institutions are giving us much valuable information that many of the food processors should use. By far the largest part of our food comes from fine, clean plants and materials, but much improvement is possible. The fish industry will be forced to establish standards of quality and quality control and, that by far the best way to have these will be through voluntary controls *within the industry itself.*

The Economic Effect of the Importation of Fishery Products on American Standards

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The importation of seafoods, and particularly of shrimp, has been a controversial subject since the closing days of the last war. Many ideas have been advanced and many arguments have ensued, but none have solved the problem. Greater imports of shrimp, year after year, have aggravated the issue. Mexico has been the chief exporter of shrimp to the United States, but other foreign countries, particularly those of South America, are now entering the picture. India will no doubt also enter into the picture in the near future. some solution must be sought for this situation. Any problem on controversial subject can be satisfactorly solved, if the will to do so exists.

Until recent years almost 100 per cent of the shrimp handled and sold commercially, came from these Gulf of Mexico waters. Let us recall the geography of the Gulf of Mexico, since it is from this body of water that about 90 per cent of the present supply of commercial shrimp is taken. In the U.S.A. the State of Texas on the western side; on the east is Florida. Between these lie Louisiana, Mississippi and Alabama. At the present time, Texas and Florida are the two largest producing states from grounds of the Mexican coast. Texas and Florida boats also do considerable fishing of shrimp off their own shores and Alabama, Mississippi and Louisiana boats do practically all of their fishing off their own shores. Much of it is in "inland" waters. Louisiana is the principal producer of domestic shrimp in the United States.

The development of the shrimp industry—boats, trawls, and other equipment

—is entirely American. United States capital, American labor and American ingenuity have developed this great industry. Many millions of dollars have been invested and standards of quality and living standards have risen as a result of this investment and effort. Fishing villages have gained new homes, new commercial buildings, new parks and recreational centers. "Poor" fishermen have become substantial and respected citizens. Many former fishermen today are owners of shrimp processing plants. Many of them own their own fleet of boats. All of them are enjoying far higher standards of living as a result of the growth of the shrimp industry. In considering the problem of imports we must always bear these facts in mind.

The following figures represent imports of shrimp from foreign countries, beginning with 1945. The figures given are in pounds of headless shrimp.

Year	*From Mexico*	*Other Countries*	*Total*
1945	7,873,888	1,901	7,875,789
1946	12,056,001	46,460	13,274,965
1947	13,228,505	187,974	12,243,975
1948	21,477,390	85,633	21,563,023
1949	29,382,193	291,012	29,673,205
1950	39,652,640	545,423	40,198,063
1951	39,575,128	2,248,785	41,923,913

From 1935, through 1944, the total importation of shrimp from all foreign countries was 36,972,073 pounds. This ten-year total is about four million pounds less than the amount imported in 1951 alone. Imports for the year 1952, will probably be far greater than the 1951 total. From these figures the magnitude of the problem can be grasped. All of these shrimp are consumed in America, in competition with American-produced shrimp. It is important to remember, in this connection that Americans, with American capital, have organized the shrimp industry in Mexico and other countries. Americans are thus competing with American producers. It is likewise important to remember, of course, that competition is the heart of every business. From this competition there comes the incentive to improve the standards of quality and the efficiency of operation; standardization follows. But *this competition* creates *the problem* that faces the industry today. The domestic industry should not be placed at a disadvantage in relation to the foreign industry. Several ideas have been advanced to solve the problem. Some have advocated the placing of tariffs on imports; others have advanced the theory of establishing an import quota. Some have advocated government prohibition of financial aid to foreign countries in the building and equipping of shrimp boats. All of these ideas have merit; none of them will solve the problem. There is another idea which has been advanced, which the writer favors, which will place all producers, foreign and domestic, on an equal basis. It should not be difficult to implement if it is carefully planned. In the United States shrimp boat owners pay their crews by a standard method of shares. The owner provides the boat and equipment to the crew and takes one half of the catch. The other half of the catch is divided among the crew. Sometimes the boat owner takes one share for the boat, another share for the gear (until the gear is paid for) and the remainder is divided among the crew. Food and fuel are paid for before the catch is

divided. When the owner takes a half share he provides the gear and rigging. If the crew heads the shrimp at sea they are paid for this labor at a fixed price. The plant operator has established minimum labor costs which are, for the most part, established by law. Other labor costs are agreed upon, between labor and management, based upon American standards of living. Thus the operators' costs are standardized, either by law or by practice. To sell to the government an operator must certify that he has conformed with all requirements relative to minimum wage and other laws. Furthermore, the minimum wage and hour laws also apply to shipments of products in interstate commerce. It is suggested that this same principle can be applied to imported fishery products. It could be specified, that before imports are allowed to come into this country that the country of origin be required to certify that fair labor practices were adhered to in their production. This would apply to fishermen, plant employees or any other labor involved. The minimum wages and hours could be set for each country by mutual agreement of representatives of industry and government in the foreign country and in the United States. In this manner the higher standards of living would result and these standards would become more uniform. Competition would then develop from which could come the survival of the fittest. Equalization of standards would eliminate unfair competition.

TECHNOLOGY AND EXPLORATORY FISHING SESSION

TUESDAY—NOVEMBER 18

Chairman—Clarence P. Idyll, Marine Laboratory, University of Miami, Coral Gables, Florida.

Exploratory Fishing in Bermuda Waters

Louis S. Mowbray

Curator, Bermuda Government Aquarium, and Advisor on Fisheries, Bermuda.

The fishing industry in Bermuda has never advanced beyond primitive types of handlining, simple seining, and the setting of wire fish traps. In the opinion of the writer and several other interested individuals, there exist possibilities for an increase in the catch by tapping the source of supply afforded by the large schools of migratory fishes which pass close to the islands in early summer on their northbound migration, and probably, to a lesser extent, on their return in October or November. Since the capital outlay for the purchase and equipping of a suitable vessel locally for the purpose of investigating this possibility has been prohibitive, advantage was taken of the knowledge that two Danish vessels were about to proceed from Copenhagen to Peru to carry out commercial fishing in those waters for two years.

Arrangements were made between the managing director of the Dansk Perunansk Compagni, Capt. Leo Henriksen, and the Bermuda Government to bring the two vessels to Bermuda to carry out exploratory fishing for a period of one month before they proceeded to Peru.

The purpose of the experimental fishing was to obtain as much information as possible in the short time available on the number of schools of bluefin tuna and false albacore and other pelagic fishes which pass Bermuda and to ascertain what methods would be the most practicable to capture the fish in quantity. Incidental to the pelagic work, some time was to be spent on the operation of shrimp trawls at depths of from 50 to 150 fathoms, on the supposition that schools of the red shrimp, *Hymenopenaeus robustus*, might inhabit the area.

The vessels were fully equipped with various types of off-shore fishing and echo sounding devices. It was hoped that, with luck, sufficient information might be obtained even in that short period to give indication as to the possibility of development of a pelagic fishery. However, the writer and the Director of the Bermuda Biological Station, Dr. Louis W. Hutchins, made it clear to the authorities that, at best, the very short-term research would have to be viewed in the light of a calculated risk.

Commercial species of fish known to inhabit Bermuda waters seasonally, but of which little is known as to abundance or duration of stay, are yellowfin or Allison tuna, *Thunnus albacares*, wahoo, *Acanthocybium solandri*, false albacore or little tuna, *Euthynnus alletteratus*, and blue-fin tuna, *Thunnus thynnus*. Skip-jack and albacore have been taken, but never in large numbers.

A tentative program for the fishing was laid out under the general direction of Dr. L. W. Hutchins. In the main it consisted of reconnaissance of the off-shore waters to a maximum distance of 50 miles, both visually and electronically, and a search with the sounding machines over the areas of the two

offlying banks, for localities suitable for the setting of bottom trawls. The execution of the plan was left to the discretion of the captains of the two craft in order that the greatest use of gear would result in the weather prevailing at the time. One or more government observers were aboard one boat during all trips. The use of a vacant aircraft hangar was obtained for the storage of spare equipment, and the drying of nets. Actual fishing operations were carried out from the port of St. George's, on the east end of the island, twenty minutes steaming time from the open ocean.

The two fishing vessels, the "Kosack" 61 feet long, and the "Skagerak IV" of 58 feet, arrived in Bermuda on May 4, 1952. The crew of "Kosack", the navigating ship, consisted of the captain and four seamen. She was equipped with an excellent deck-winch which was operated through a take-off from the main propulsion unit, a Burmeister-Wayne diesel engine. An echosounder of European make which was both recording and visual gave good service. Its range was to 400 fathoms. "Skagerak IV," a slightly smaller version of the other ship, had a less efficient engine, and a recorder with a range of only 50 fathoms, but there was no difference in efficiency of action in the crews. "Skagerak's" crew consisted of the captain and three others.

The gear operated in the experimental fishing was of the types which are standard in the North Sea: a purse seine of 200 x 20 fathoms, varied-mesh gill nets, a modified Larsen trawl, shrimp nets, a Danish seine (a bottom trawl without vanes), and long-lines.

In May numerous schools of blue-fin tuna have been observed passing close by Bermuda, within 20 to 50 miles to the eastward. Black-fin tuna are present in some quantities all year round, but in June they have been observed in large schools, although irregularly. False albacore and wahoo are also year around inhabitants of these waters, and occur in schools of greatly varying size. Yellow-fin tuna have been taken in small numbers in every month, but little is known of the time of greatest abundance. The largest of the species taken locally was caught in February, 1952, and scaled 236 lbs. Blue-fin have been taken on rare occasions in April, October and early November.

Very little choice was possible in the selection of the season for the exploratory work, which had to be done to fit in with the schedule of the vessels en route to Peru. In general, the months of April, May and June, when the work was done, are those in which the migratory fish arrive or pass by Bermuda. During May and June good weather normally prevails, but this project, like so many other similar efforts, was not to be favored with normal weather. It had been anticipated that fishing could take place on at least 21 days of the period. In actual fact only on 17 days was fishing possible at all, and on several of those days it had to be suspended due to high winds and seas.

Probably the most important piece of equipment used was the fleyder-trawl, a modified Larsen trawl or floating trawl. This was operated between two boats and handled with the greatest of ease by the extremely well trained crews. For the most part this was operated "blind", though on occasion it was set after indications of fish or plankton were found on the echo recorder. Sets were made in depths varying from 7 to 150 fathoms. The gear was run at night as well as during the day. No success was experienced in catching commercially important species. A few pilchards, *Harengula callolepis*, were taken in daylight sets at 35 fathoms, and a conglomerate collection of plankton, small

deep-sea fishes (mainly Stomiatidae), and several species of unimportant shrimp were captured at night. The shrimp most prevalent in the night sets was a transparent form, related to *Penaeus*, and identified as *Funchalia villosa* (Bouvier). Most of the latter species were taken at a depth of 15 fathoms, sets at 35 fathoms producing almost nothing.

Of the plankton, the most valuable hauls scientifically were those which produced considerable numbers of late-stage larvae of the spiny lobster, *Panulirus argus*. Phyllosoma were found in depths varying from 15 to 35 fathoms from 5 to 45 miles off-shore.

The boats always worked as a team. Following are excerpts from the combined log of "Kosak" and "Skagerak IV" for 29-30 May, 1952, a typical day except for the weather.

> "Arrived Challenger Bank 4:30 a.m. Quiet weather. "Kosak" dropped 80 shark hooks on longline in 28 fathoms in 65.02W 32.06N. "Skagerak" set out bottom trawl. Destroyed a seine. Tried again. Same result. Two seines destroyed in 3 sets. Fishing with the bottom trawl impossible in this area. While "Kosak" was drifting with his hooks he caught about 30 fish, mostly rockfish, on handline, and salted them for bait.
>
> "11 a.m. The hooks were hauled in. No sharks.
>
> "12 noon. Set out for S. W. Breaker to search the bottom from the Breaker to Long Bar, looking for plankton and fish. Arrived at 1:25 p.m. Plenty of plankton and shrimp fry, according to graph. Tried hand-feeling in a shoal with fine brass wire, but no "pushes" were to be noticed. Finished at 7 p.m.
>
> "Went to deeper water. Set out fleydertrawl at 8:30 p.m. at a depth of 75 fathoms in 1900 fathoms of water. Towed trawl for 4 hours. No fish except small deep-sea fishes and shrimps. Put some in formalin. Left for St. George's at 1:45 a.m., arrived at 6:00 a.m. On Challenger Bank we saw two humpback whales, and "Skagerak" saw a manta ray about 12 feet broad."

The bottom trawl referred to is that type of gear used almost exclusively by the Danish fishermen in the North Sea until the Larsen trawl was developed several years ago. The trawl itself consists of a small seine of about 45 feet in length, with a cork and lead line. To set the trawl, a flag buoy is dropped, to which is attached one end of the drag rope. Several hundred fathoms of one inch diameter rope is then played out, followed by the net and then an equal length of rope. The set is made so that the towing end will be brought back to the float. The rope sinks and the seine sweeps the bottom. As the rope is drawn in the fish are driven toward the center and eventually are swept into the net. This method produces considerable quantities of fish where the bottom is suitable.

Gill nets were set on six occasions. The shortest time of drift was six hours but the average was ten hours. The nets covered a stretch of something over one and one half miles in length, and the meshes of the nets varied in size from 2 inches to 6 inches stretched measurements. All sets were made during the hours of darkness. No success whatever accompanied this method of fishing. Surprisingly, not even flying fish were taken.

No success rewarded the efforts with the shrimp trawl, but that is not surprising because suitable bottom was not located in the short time spent on the

phase of the work. The maximum depth at which any of the nets could be set was 150 fathoms, and as the successful drags for the red shrimp in the Gulf of Mexico have been in depths around 200 fathoms, it is probable that the proper areas, if they exist, were not reached with the gear.

Long-lines were set on six trips. One boat fished for sharks with 200 hooks (4 boxes), 4 fathoms down in 30 fathoms of water. The other boat set out 350 salmon hooks, at depths from 2 to 10 fathoms, in the same area. Lines were left out for 10 hours and then hauled just before daylight. The shark line had 2 tiger sharks of 400 and 300 lbs., and 24 dusky sharks, *Carcharhinus obscurus*. Sixty hooks and leaders were missing. One dusky shark weighed nearly 500 lbs. and contained 10 young, which would have been born within a week. They were 29 inches in length. The other sharks of the same species averaged about 15 lbs. in weight. The salmon hooks were rigged with heavy nylon monofilament leaders and 70 were cut off. There were no fish landed from that set. On other occasions a few small sharks, a barracuda, and a black-fin tuna were taken.

During all daylight operations a close lookout was kept for surface schools of fish, but aside from several schools of scad (*Decapterus*) none were sighted. In consequence, there was no opportunity to use the purse seine. On one occasion this was set to demonstrate its action to a group of local commercial fishermen who had been invited by the government to go along to watch the procedure. When the recorder indicated concentrations of fish or plankton in depths workable by the gear aboard at the time, sets were made. In each instance the mass proved to be small shrimps or other plankton. No commercial species of shrimp or fish were captured by seine or trawl. Greater use of the long-line probably would have produced more tuna, but as that is a simpler and less expensive form of fishing, which could be carried out locally, little time was spent on it.

In making recommendations for the exploratory work to be carried out by these vessels it was consistently pointed out to the local government that the results of such a short-term project would not be conclusive, whether it be favourable or adverse. The opinion of the writer before the work began, and which remains unchanged, was that the only chance of real success would be through the use of the purse seine after visual or electronic contact with schools of tuna, false albacore, or wahoo had been made. No real hope was held out for success with mid-water or bottom trawls or seines due to the fact that nothing in the past led to even a suspicion that species which could be readily taken by those methods were inhabiting the area.

The experiment was of far too short duration to warrant definite conclusions being drawn. However, indications are that there is little or no likelihood of locating commercially valuable bottom species. On the other hand, the fact that no schools of tuna or mackerel-like fishes were sighted is far from proof that they were not present at that period, or that similar efforts during the same season in subquent years will not be successful.

Long-lines, set at varied levels, seem to offer a fair return for effort expended. It is highly probable that consistent fishing by this method would produce important quantities of yellow-fin tuna. Sharks will remain a menace to this type of operation, but if there are large quantities of sharks available then a new fishery may result.

The fact that 1952 produced a considerably smaller than average fishery catch off Bermuda, and reportedly along the eastern coast of the United States and Nova Scotia, the conclusion is that considerably more exploratory fishing must be carried out before the situation can be evaluated

The Bermuda Government has recently purchased and partially equipped a 60 foot long motor fishing vessel for future exploration. The craft was obtained from the British Admiralty at a very favourable price. It is intended that a five year research plan will be carried out under the general direction of the Bermuda Biological Station for Research, concurrently with oceanographic work already under way by that institution. The vessel has just been put into commission, and exploratory work on fisheries will probably commence in April, 1953. It is hoped that a satisfactory progress report may be presented at the next session of the Gulf and Caribbean Fisheries Institute.

Shrimp Exploration of the M. V. Antillas

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Under a cooperative agreement between the Gibbs Corporation of Jacksonville, Florida, and the Fish & Wildlife Service, the M. V. "Antillas" has been searching for new shrimp resources, primarily in areas which could be exploited by the existing class of shrimp trawlers. The exploratory work started early in April off Florida and Georgia and about a month was devoted to searching for shrimp and favorable bottom at depths beyond the range of the existing fishery. Two trips were made to Central America, one during May and June and the second during July. During September and October, the primary effort was devoted to deep water red shrimp of the upper Gulf of Mexico and the "Antillas" is now working on the Bahama Banks.

Florida & Georgia

A total of 78 sets were made in the offshore area from Brunswick, Ga. to Port Pierce, Fla. at depths from 5 to 130 fathoms. The drags in shallow water were primarily made to assure proper functioning of the gear and for gear development work. While the work was done in the off season for white shrimp, quantities varying from a few to several pounds, and on one occasion up to 160 pounds, were taken during random drags on known grounds having mud bottom. Outside of these areas no commercial species of shrimp were found and only small quantities of fish, most of which are not market species, were taken. With the exception of the known fishing areas, no mud bottom was found until reaching depths of 80 to 100 fathoms. The bottom in the intervening area as shown by soundings was primarily various mixtures of sand and shell. A patch of mud bottom was found about southeast of Cape Canaveral and was explored from depths of 80 to 130 fathoms. While somewhat larger quantities of fish were found in this area than on the sand bottom, the catches were not of commercial magnitude. A small patch of bottom having some mud mixed with sand was found near the 20 fathom curve about south southeast from Cape Canaveral but no shrimp were taken.

As the 100 fathom curve was approached, the effect of the Gulf Stream became quite pronounced and surface velocity approached or exceeded trawling

speeds. Under these conditions it was almost impossible to maneuver the vessel properly and hold a predetermined course or depth. Since no extensive areas of mud bottom were found outside the known fishery or in areas where otter trawls could be satisfactorily operated, there is considerable question if any substantial unexploited new shrimp resources exist in offshore waters of northern Florida and southern Georgia. However, the work was performed only during one month of the year and explorations at other seasons might yield better results.

Honduras and Nicaragua

A preliminary exploration for shrimp off the coasts of Honduras and Nicaragua was made during the last four days in May. A total or 64 tows, comprised of 57 with "try nets" and 7 with "balloon trawls", were made off a stretch of coast line about 220 miles long between Cabo de Honduras, Honduras and Gorda Point, Nicaragua. In July the area was resurveyed and a total of 39 tows were made, mostly with a try net. It was intended on both of these trips to spend several weeks in the area, but circumstances reduced the time spent on the grounds.

Physical Characteristics of Area

The bottom along the north coast of Honduras from Guatemala to Cabo Honduras appeared to be generally hazardous for trawling, according to readings on the automatic depth meter. From Cabo Honduras to Miskito Channel, Nicaragua, a distance of over 200 miles, mud bottom predominates and is generally suitable for otter trawling between depths of 4 and 20 fathoms. Rough patches were frequently found at depths in excess of 20 to 25 fathoms. Also, the rivers and lagoons in the area probably have deposited portions of trees near their mouths which may be hazardous to gear if fishing were conducted inside the 3 mile limit. The land adjoining the area of good bottom is low and large rivers and lagoons are common. These geographical features should be conducive to populations of shrimp. Unfortunately, harbors are few, and numerous reefs lay outside the mud bottom which could be a menace to navigation.

Grooved Shrimp

During May grooved shrimp were found over much of the area surveyed, at depths varying from 8 to 20 fathoms, but no concentrations in any way comparable to the Campeche or Tortugas fisheries were indicated. The catch in try nets during a 15 minute tow generally varied from one to ten shrimp. Two drags at night with a balloon net, in areas where the try net yielded four grooved shrimp, resulted in catches of 42 pounds, about half of which was in the range of 15 to 30 count and the other half in the range of 30 to 60 count. During July the drags were made at distances from 4 to 60 miles offshore and in depth ranges of 4 to 35 fathoms. Again grooved shrimp were found to be widely scattered, chiefly between distances of 5 to 15 miles offshore with the best catches being made between depths of 14 and 19 fathoms.

The similarity of the results obtained on grooved shrimp during both May and July indicates a wide dispersion, but in view of the size of the area a rather large number of individuals must have been present on the grounds. The results, when considered in the light of experience elsewhere, indicate that the schooling of grooved shrimp off Honduras and Nicaragua, if it occurs, is seasonal. Since so little is known about the area two other observations may

be in order. First, with the limited time available, the schooling areas could have been missed and or, second, the area prospected may be a feeding or reserve area for some so far undiscovered schooling ground. In the present limited explanation only a very small portion of the bank off Nicaragua and Honduras could be surveyed.

White Shrimp

During May no white shrimp were found at depths in excess of four fathoms, but there were good indications that substantial quantities might be found within the three mile limit off Nicaragua. During July some white shrimp were found at depths of six and eight fathoms and several commercial vessels fishing near shore made substantial catches. First hand reports from several commercial trawlers, who made trips in August and September to Nicaragua for white shrimp, indicated a seasonal variation in abundance, since the catches become progressively lower. This decline in the catch might indicate the end of one season, with the expectation that a new one might soon start. The size of the white shrimp was quite acceptable to the trade, being mostly in the range of 20 to 30 shrimp per pound.

Red Shrimp

During 1950 and 1951 the Fish and Wildlife Service M. V. "Oregon" found red shrimp, *Hymenopenaeus robustus*, at depth between 180 and 350 fathoms, with the main concentration appearing to be between 200 and 250 fathoms. The "Antillas" spent part of September and October in what appeared to be the most favorable portion of the fishery discovered by the "Oregon", for the purpose of test fishing with large shrimp trawls to determine the commercial possibilities of the grounds.

The "Oregon's" best catches were southeastward of the Mississippi Delta and were made with special 40 foot trawls. Their trials with commercial gear met with less encouraging results, since the soft mud bogged down the larger nets, causing six gear failures out of eight drags.

One of the first problems requiring attention was the modification of conventional shrimp gear to permit fishing at depths to 300 fathoms, and devising gear that would withstand the strains involved. During initial trials standard equipment and hook-ups were used, with the exception of floats capable of withstanding the pressure at a depth of 400 fathoms, and of a weight of 140 pounds added to the back side of each otter board. The doors were crossed while setting on the first three trials but changing the attachment of the trawl from the trailing end to the rear side of the doors overcame this difficulty When it became obvious that "mudding-down" would be a serious problem, the runners of the doors were increased to a width of eight inches for greater bearing surface. Mud ropes were also attached to the foot ropes of the trawls. Eventually all the trawls fitted with mud ropes were lost, and it was found that the one-half inch diameter manila-clad wire rope combination used for foot rope was of inadequate strength for the deep water work. A new trawl made of 24-thread twine instead of the conventional 18-thread twine, and having a 6 x 19 ply plow steel cable for a foot rope, proved much superior to conventional trawls for the deep water work over soft mud bottom. Before hanging the trawl the wire foot rope was served with ⅝" diameter rope. Either this type of foot rope had superior advantages on soft bottom or it was used on firmer bottom, for the trawl did not mud down, although the otter boards showed evi-

dence of the bottom being equally soft. Of a total of 33 drags with balloon and flat trawls, 5 resulted in completely destroyed or severely damaged nets. On 2 other sets considerable damage to the net resulted. A total of 17 successful sets were made consecutively with the revised trawl.

The "Oregon" and the "Antillas" worked cooperatively on one day to determine more rapidly the depth range in which the red shrimp might be found. They were most abundant between 195 and 220 fathoms. In the depth range of 220 to 240 fathoms the red shrimp were generally larger, but the quantity taken rapidly decreased with increasing depth. Shallower than 195 fathoms the red shrimp population was replaced by a cocktail sized pink shrimp *Penaeopsis megalops,* having an excellent flavor.

The bottom on which the red shrimp were found consists of a narrow strip along the edge of the continental shelf, only a few miles wide. The bottom is very soft mud with occasional "snags," which may be rocky out-croppings, and frequent changes in heading were required to hold a constant depth. Difficult fishing conditions would constitute a further drawback in taking red shrimp commercially. The succession of northerly winds which interrupted the operations of the "Antillas" during most of October were considered unusual, but on the 200 fathom curve trawlers should expect more unfavorable fishing weather than on the inshore grounds.

The best catches, about a basket (80 lbs) of heads-on red shrimp, were made on the steepest part of the edge which lies directly south of the area between Pascagoula and Mobile. The location of the best catches suggests that the red shrimp were not necessarily more abundant along the steep slope, but were more concentrated within the narrow confines of their depth range, for both to the eastward and westward where lesser slopes prevail within the range, poor catches resulted.

An analysis of the problems involved raises some doubts about the possibility of successfully exploiting the red shrimp fishery at the present time. The species has a very pleasing flavor and should eventually command a premium price, but at first it would probably have to be sold at a competitive price with similar sizes of the commercially established species. This would make profitable fishing for red shrimp problematical, considering the high cost of producing the new species. At least one hour's time would be required to set and haul the trawl, and the hazards to gear are relatively high. Furthermore, a few random drags for brown shrimp at depths between 40 and 70 fathoms indicated that the commercial fishery for this species might be extended to depths of 60 fathoms and that better returns might be expected than from red shrimp. The brown shrimp taken in deep water were mostly in the 10 to 15 count range while the red shrimp could be divided into 2 groups, about half in the range of 15 to 25 count (females) and half in the 30 to 35 count range.

Problems of Exploitation of Tuna in the Gulf & Caribbean

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Tuna are caught by commercial fishermen in a variety of ways, with poles and feathered squids after chumming with live bait, by purse seines, by trolling, with set lines (i.e., longlines or flaglines), by harpooning, and with various kinds of trap nets. It is convenient to separate tuna fishing operations into two classes, based on the distance it is necessary to travel in order to catch the tuna. Long range tuna fishing vessels going long distances to extensive offshore fishing grounds need to be relatively large, and unless accompanied by motherships or by large vessels to take care of the catch, they need large refrigerated carrying capacity, large fuel capacity, as well as supplies for a long voyage for the crew. Whether or not each fishing vessel acts independently or is a part of a fleet including a mothership or tender, the total cost of the fishing unit is very high compared to the cost of units operating close to a base. This means that the catches have to be large and valuable in order to make the operation pay. On the other hand, short range tuna fishing operations do not require such expensive fishing units. They have drawbacks however, either because of the seasonal occurrence of tuna for very short periods near their bases, or because of difficulties of coordination of landings with processing or marketing. In the West Indies, as in the United States, the demand for fresh tuna is slight. The demand, where it exists, is for canned tuna.

A successful short range tuna fishery has been in existence in Cuba since 1942 (Rawlings, 1953). The production, consisting of blackfin tuna (*Parathunnus atlanticus*) and white skipjack, (*Katsuwonus pelamis*) comes froms waters within a few miles of the reefs near the Isle of Pines and to a lesser extent from the northwestern coast. This is a part-time fishery and the tuna are canned and marketed in Cuba by canneries working seasonally on a variety of products. Development of additional short range tuna fisheries in the West Indies is feasible wherever suitable processing facilities become available and local markets for canned tuna are sufficient.

The kind of short range fishing most likely to prove successful in the Gulf and West Indies would depend on local conditions. Low cost gear and the simplest possible methods of handling catches are necessary to the success of a very small or part-time fishing operation, and it is significant that the Cuban fishing is carried on with live bait. The bait, small fish about one to three inches long, (mostly *Jenkinsia lamprotaenia*) is obtained close to the fishing grounds and is carried in live wells until used. Up to the present time the live wells in the Cuban boats have not been equipped with circulating pumps and it has been impossible to keep the bait for more than a day. As a result the fishermen spend much more time catching bait than actually fishing for tuna. The method of fishing used by the Cubans has the advantage of relatively low cost for fishing vessels and gear. Fishing for tuna with live bait as chum, and catching and handling live bait does require considerable skill and experience and the use of the method in other areas of the West Indies would require not only a good source of supply of bait but also training of fishermen in techniques.

The *Oregon*, the exploratory fishing vessel of the Fish and Wildlife Service in the Gulf of Mexico, caught little tuna, *Euthynnus alletteratus*, on the Tortugas shrimp grounds during the slack shrimp season in the summer of 1952, using feathered squids, dead bait and chum made from scrap from shrimp trawls. Catches of 1500 to 4000 pounds were made on each of several mornings, during the two hour period beginning at dawn. Production of little tuna as a part-time activity by shrimp vessels during seasons of poor shrimp production appears possible whenever arrangements for marketing become satisfactory.

Possibilities for much greater production in the Gulf and Caribbean exist in fishing for tuna at considerable distances from bases. In the Gulf of Mexico the tunas, except the little tuna, are rarely found on the continental shelf, appearing to be widely distributed in summer off the shelf, usually at distances of more than 75 miles from shore. In the Caribbean the tunas are commonly taken closer to island shores, but often at great distances from ports. Furthermore, observations suggest that the tunas move seasonally or irregularly, so that long range fishing would be necessary to maintain steady production.

There are not enough records to indicate reliably the distribution of the tunas in the Gulf and Caribbean. Those available suggest that the black-fin tuna, *Parathunnus atlanticus*, is widely distributed and is probably the commonest one in offshore waters from the north Gulf to the lesser Antilles. There are fewer records of the yellow-fin tuna, *Neothunnus argentivittatus*, but these records indicate wide distribution. The white skipjack, *Katsuwonus pelamis*, has been taken by the *Oregon* in the Gulf and the Straits of Florida in summer, and was observed in considerable quantity in the Straits of Florida. Small white skipjack make up about 25 per cent of the tuna catch taken by the Cubans off the Isle of Pines, but the distribution in the West Indies generally is uncertain. The three species mentioned above are valuable to the fishery and produce a good quality canned product. Most of the black-fin tuna taken have been small and the average weight of black-fin tuna from the Cuban fishery is from three to four pounds. There are indications that black-fin tuna found in the offshore waters are somewhat larger, and the value of the species to a live bait fishery will be substantially greater if larger fish are regularly obtainable.

Estimation of the abundance of tunas by observation from boats is difficult. Observations from the *Oregon* lead to the opinion that the tunas in the Gulf generally do not show at the surface except when the weather is calm and the sea smooth. In the north Gulf of Mexico tunas of the three species mentioned have been commonly observed in the late afternoon and to a lesser degree at dawn. It is perhaps significant that tunas were brought to the surface twice during dragging by the *Oregon* when a shrimp trawl was lifted after a drag made at depths of 200 to 250 fathoms. Various indications, such as occasional but uncommon catches on trolling lines when surface signs of tuna are absent, or observations of resting birds, possibly waiting for one of the periodic appearances of tuna at the surface, suggest the presence of the tuna in the Gulf normally well below the surface.

Although many small schools of tuna were observed in the Gulf from the *Oregon* in the summers of 1951 and 1952, conditions were generally unsatisfactory for purse seining. The water was very clear and the schools

were not tightly packed but were scattered over a considerable area. The combination of clear water, scattered small schools and appearances at the surface late in the day presented too many difficulties for purse seining and no fish were taken by that method.

Several types of small fish are found in the Gulf and West Indies area in sufficient abundance to give promise of good sources of supply for live bait fishing. Weather conditions throughout a large part of the year are unfavorable, but how serious this is can only be learned by actual trial. Operations south of the hurricane belt are a practical possibility during hurricane season. There are some indications, too, that the tunas are more easily found in the extreme southern Caribbean in the months of December, January, and February. Any understanding of the potential of a live bait fishery for tuna in the area should come from exploratory fishing with live bait carried on over a period of more than a year.

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Some Practical Aspects of Electric Fishing in the Sea

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A great amount of interest has developed among commercial fishermen in recent years concerning the possibilities of using electrical methods of catching fish in the sea. In this paper the writer intends to present some of his current ideas and conclusions on this method of fishing arising out of a review he has made recently of literature dealing with this subject.

The application of electric fishing methods in the sea involves the establishment of an electric field of the required current density and distribution in a specified volume of sea water at periodic intervals of time.

For satisfactory results the apparatus for electric fishing must be capable of setting up at the boundary of a specified volume of water an electric field of such current density that a condition of electro-taxis is produced in a fish of a given size and species. This is a condition in which the fish orients itself in the electric field with its head pointing toward the anode or positive electrode and involuntarily swims in the direction of that electrode.

As the electric field in a continuous medium such as a large body of water spreads out in all directions from an electrode in an approximately radial manner, the current density in regions outside the boundary in which electro-taxis occurs will be too low for producing this effect. Any fish in these regions will be frightened by the uncomfortable electric field and will try to escape from it. In regions within the boundary for electro-taxis, however, the current density increases rapidly in the direction of the electrode and will everywhere be at least equal to or greater than that necessary for causing a condition of electro-taxis. Conceivably a fish swimming toward an electrode in a condition of electro-taxis would soon reach a region where the current density would be sufficient for producing a condition of paralysis. Should this happen the fish would become incapable of any further movement and probably would turn belly up and slowly sink toward the bottom. If the electric field were maintained for a long enough period of time while the fish were in this condition, it would die.

In water of a given resistivity the current density necessary for producing a condition of either electro-taxis or paralysis has to be determined experimentally for each species and size of fish. For a given species of fish, experimenters have found that there is an inverse relationship between the length of the fish and the current density required for paralysis. On the basis of data obtained while experimenting with salmon fingerlings and trout in fresh water having a resistivity of 10,000 ohms per inch cube, McMillan (1928) found that the relationship between the length of fish and the voltage gradient for paralysis could be expressed by the equation:

$$g = \frac{3.70}{L}$$

where g is the voltage gradient per inch to produce paralysis and L is the length of the fish in inches. Since the current density is equal to the voltage gradient per inch divided by the resistivity, this equation can be written in terms of current density as:

$$i = \frac{3.70}{\rho L}$$

where i is the current density in amperes per square inch taken in a section at right angles to the electric field and ρ (rho) is the resistivity of the medium in ohms per cubic inch.

McMillan also established that water resistivity has a very great affect on the voltage gradient necessary for paralysis. In a series of tests made in 1928 on salmon fingerlings in water, varying in resistivity from that of sea water having a resistivity of 11.6 ohms per inch cube to that of mountain-stream water having a resistivity of about 10,000 ohms per inch cube, he found that the minimum voltage gradient for paralysis changed from .27 volts to 1.23 volts per inch, or about 4.55 times. This led him to introduce a correction factor "W" for water resistivity in the voltage gradient equation above as follows:

$$g = \frac{3.70W}{L}$$

Using McMillan's value of W for sea water of .219, the above equation reduces to:

$$g = \frac{3.70 \times .219}{L} \text{ or } \frac{.81}{L}$$

This may be written in terms of current density as:

$$i = \frac{.81}{\rho L}$$

The ideal distribution of the current flow for electric fishing would be one in which the current density was uniform throughout the entire volume of the water between the electrodes. While it is possible to obain a fairly uniform distribution of current flow in a tank or trough of uniform cross-section, it is extremely difficult if not impossible to achieve such a distribution of current flow between electrodes immersed in a large body of water. Jeans (1908) has shown that the lines of current flow between two electrodes in a continous medium are identical with the electrostatic lines of force which exist when two electrodes are charged to different potentials in air. This means that the lines of current flow from an electrode immersed in a large body of water tend to spread out radially in all directions from the electrode. When the physical

size of the electrodes is small in comparison to the volume of the medium in which they are immersed, this radial spreading of the current is practically independent of electrode shape. The fact that an electrode is a sphere or a flat plate has little or no effect on the radial spreading of the current. Therefore, it can be said as a rather rough approximation that the current density varies inversely as the square of the distance from an electrode.

The rapid spreading of the current from an electrode deeply immersed in a large body of water requires a very large flow of current from the electrode to produce a current density sufficient for paralysis at a distance of only a few yards from the electrode. Assuming a uniform radial spreading of current, it can be shown that the total electrode current must approach a value of about 6530 amperes to produce a current density of 4 milli-amperes per square inch at a distance of 10 yards from an electrode. The current density used in this example is that necessary for paralyzing a salmon 20 inches in length as computed by McMillan's equation for the paralysis voltage gradient. To produce this current density, assuming that the resistance between the electrodes and the medium is about .25 ohms, the electrical apparatus must be capable of supplying at the electrodes about 10,700 kilowatts of power at 1630 volts. To extend the same current density out to a distance of 20 yards from the electrode, the total electrode current required is about 26,200 amperes and the apparatus must be capable of developing at the electrodes 171,200 kilowatts of power at 6520 volts. The total current in each instance here has been computed using the following equation which is valid for a uniform radial spreading of current from an electrode:

$$I = 4 \pi R^2 i$$

where I is the total electrode current, R is radial distance from the electrode in inches, and i is the current density in amperes per square inch.

The power required for electric fishing can be reduced by using short, periodic pulses of current instead of continuous current. As an example, suppose that square wave pulses of 2 milli-seconds duration are repeated at a rate of 50 per second. Then the current is on for only 100 milli-seconds or for only one-tenth of a second out of each second. This means that electrical apparatus in the examples above would need to provide only one-tenth of the amounts of power indicated there or about 1070 and 17,120 milowatts respectively.

Experimenters have observed also that some pulse shapes or waveforms and pulsing rates are more effective on fish than others. A recent report from Europe indicates that the German scientists, Kreutzer and Peglow, have determined that a square wave pulse of 2 milli-seconds duration repeated 50 times a second is very effective on cod and herring. At the California Academy of Sciences, Groody, Loukashkin, and Grant (1952) have found that the movements of sardines can be controlled effectively by means of sawtooth shaped pulses of 133 milli-seconds duration repeated 5 times a second. This indicates that the best waveform and pulsing rate have to be determined experimentally for each kind of fish.

It should be apparent now that the principal limitation to the application of electric fishing methods in the sea in a practical way at present is imposed by the radial spreading of the current from the electrodes. Because of this spreading of the current, the power capacity of the electrical apparatus aboard

the ship must be very great to set up a current density of a few milli-amperes at a distance of only a few yards from an electrode. Future research in this field should be directed toward finding methods of concentrating or confining the electric field to a limited volume of water between the electrodes in so far as may be possible. Laboratory experiments should also be carried out to determine the correct current densities for producing the conditions of electro-taxis and paralysis in various kinds of commercially valuable fishes, as well as the best waveform, pulse length, and pulse rate to use with these fishes. Having ascertained these factors it will be possible to estimate the electrical power required and proceed with the assembly of the apparatus needed for applying electrical methods of fishing to a particular fishery in a practical way.

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Holding Fresh Shrimp in Refrigerated Sea Water[1]

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During the past several years shrimp boats in the Gulf of Mexico have been making longer and longer trips. The greater length of time spent away from port has increased the difficulty of landing high quality fresh shrimp. In addition, present icing methods result in a condition known as "black spot" on the shrimp. (Figure 1.).

The need for more efficient methods of refrigeration and control of the black spot problem led the Marine Laboratory of the University of Miami to conduct a series of experiments, for the Florida State Board of Conservation, in which shrimp were held in refrigerated seawater instead of in crushed ice.

Preliminary tests were conducted in which the quality of iced shrimp was compared with that of shrimp held in sea-water, fresh water, and solutions of calcium chloride and sodium chloride. Pink grooved shrimp (*Penaeus duorarum*), caught by a commercial trawler off Key West, were held in the various solutions at temperatures which ranged between 37.9° and 41.7°F. The quality of these shrimp was tested seven times over a period of 24 days. A testing panel of ten staff members of the Marine Laboratory rated the shrimp as to firmness, black spot, odor and taste. (Table 1).

[1] Contribution No. 94 from The Marine Labortaory, University of Miami.

TABLE 1

PALATABILITY SCORES OF SHRIMP HELD ON ICE AND IN VARIOUS SOLUTIONS
MAXIMUM SCORE: 4.0

Days Storage Time	ICED Taste	Odor	Black Spot	Firmness	CALCIUM CHLORIDE Solution 33 °/oo Av. holding temp.: 38.3°F Taste	Odor	Black Spot	Firmness
5	2.0	3.5	2.3	2.7	3.2	3.7	3.4	2.8
7	3.4	3.9	2.2	2.8	2.1	3.7	2.2	3.4
10	3.4	3.9	2.6	3.2	2.3	3.7	2.6	3.3
12	2.8	3.3	2.2	3.2	2.0	3.5	1.7	3.3
17	..	..	..	..	2.0	3.4	1.8	3.5
21	..	..	..	..	1.6	3.8	2.1	3.4
26	..	..	..	..	..	3.3	2.7	3.1
	FRESH WATER Av. holding temp.: 41.7°F				SEA WATER Av. holding temp.; 38.6°F			
5	3.1	3.9	3.9	3.1	3.8	3.5	3.1	3.9
7	3.4	4.0	4.0	3.2	3.7	3.6	3.3	3.5
10	3.1	3.9	3.6	3.2	3.2	4.0	3.3	3.7
12	3.1	1.8	4.0	2.6	3.5	3.2	3.6	4.0
17	1.7	2.4	4.0	2.9	2.7	3.1	3.9	3.3
21	2.7	1.7	4.0	3.3	3.0	3.2	3.7	3.5
26	..	2.3	4.0	2.9	..	3.3	2.7	3.1

	SODIUM CHLORIDE Solution 33 °/oo Av. holding temp.: 38.3°F			
5	3.9	3.7	3.0	3.6
7	3.7	3.6	3.3	3.6
10	3.2	4.0	3.3	3.5
12	3.5	3.2	3.6	3.7
17	2.7	3.1	3.9	3.8
21	3.0	3.2	3.7	3.8
26	..	3.3	2.7	3.7

The palatability of the iced shrimp in this experiment declined rapidly, and moderate amounts of black spot developed. This sample was discarded after the 12th day. (Table 1).

Shrimp held in a solution of calcium chloride were objectionable on the 12th day. These shrimp became noticeably bitter, on the 7th day. Large amounts of black spot developed on these shrimp by the 12th day. (Table 1.).

Ratings of taste (1.7) and odor (2.4) made the fresh water-held shrimp objectionable by the 17th day. (Table 1). However, this sample showed little evidence of black spot. The quality of the shrimp held in seawater and sodium chloride solution remained acceptable until the end of the experiment. (Table 1.). There was no significant development of black spot in either of these latter samples.

These preliminary results indicate that fresh shrimp held in seawater or sodium chloride would be more acceptable to the consumer than shrimp held in crushed ice, calcium chloride or fresh water.

The encouraging results from the tests with sodium chloride and seawater-held shrimp warranted further experimentation. Therefore a more detailed study was made of the quality of shrimp held in refrigerated seawater.

FIGURE 1. Sample No. 1 was held in refrigerated seawater for 16 days at 31.0°F. Sample No. 2 was held in crushed ice for 16 days. The blackened areas at the edge of the segments of the shell on sample No. 2 are typical of "black spot" (melanosis) which develops on ice-held shrimp. The unmarked appearance of sample No. 1 is typical of the condition of shrimp held in refrigerated seawater.

Samples of shrimp used in this experiment were taken from a single drag made by a commercial shrimp trawler operating on the Tortugas grounds.

TABLE 2
BLACK SPOT SCORES
MAXIMUM SCORE: 5.0.

Days Storage	Seawater 15% changed daily		Seawater Unchanged		Ice Held	
	Heads Off	Heads On	Heads Off	Heads On	Heads Off	Heads On
	Average holding temperature °F					
	34.8	34.7	30.7	32.4	32.0	32.0
2	4.9	5.0	4.9	4.8	5.0	4.8
4	5.0	5.0	5.0	4.0	4.8	4.0
6	5.0	4.8	4.8	5.0	4.0	4.0
8	5.0	5.0	5.0	4.9	4.0	4.0
10	5.0	5.0	5.0	5.0	5.0	3.4
12	5.0	5.0	5.0	4.8	3.8	3.8
13	5.0	5.0	5.0	5.0	3.4	4.2
15	5.0	4.6	5.0	5.0	3.6	3.8
17	5.0	5.0	5.0	5.0	4.0	4.2
19	5.0	..	5.0	..	4.0	3.8
22	5.0	..	4.8	..	3.4	..
24	5.0	..	5.0	..	..	..

These shrimp were placed in refrigerated seawater or crushed ice within one hour after being caught. Crushed ice samples were held at 32° F. throughout the experiment. The temperature of the seawater samples ranged from 30.7° to 34.8° F. (Table 2).

Eleven series of bacteriological tests were made on the seawater and the drip from the iced samples. Numbers of bacteria per cubic centimeter of seawater were determined by the dilution extinction method of Zobell (1948). No attempt was made to identify the bacteria.

Taste, odor and black spot were used as the criteria of quality. Values ranging from one to five were assigned to each quality tested. A rating of five denoted the highest quality shrimp, while a rating of one described inferior quality. In these tests an arbitrary score of 3.5 was established as the limit for "good" quality shrimp. This standard is higher than the quality of shrimp accepted by the consumer. Only boiled shrimp without condiments were served to the test panel. Had these shrimp been french-fried or served with sauce they would probably have remained acceptable for a longer period of time.

Six samples of shrimp were tested in this experiment. They were grouped in pairs, each pair consisting of a heads-on and a heads-off sample. One pair of samples was held in crushed ice, one pair in unchanged seawater, and the third pair in seawater. Fifteen per cent by volume of the seawater was changed daily on the third pair of samples.

Results of this experiment again indicate that a higher quality product may

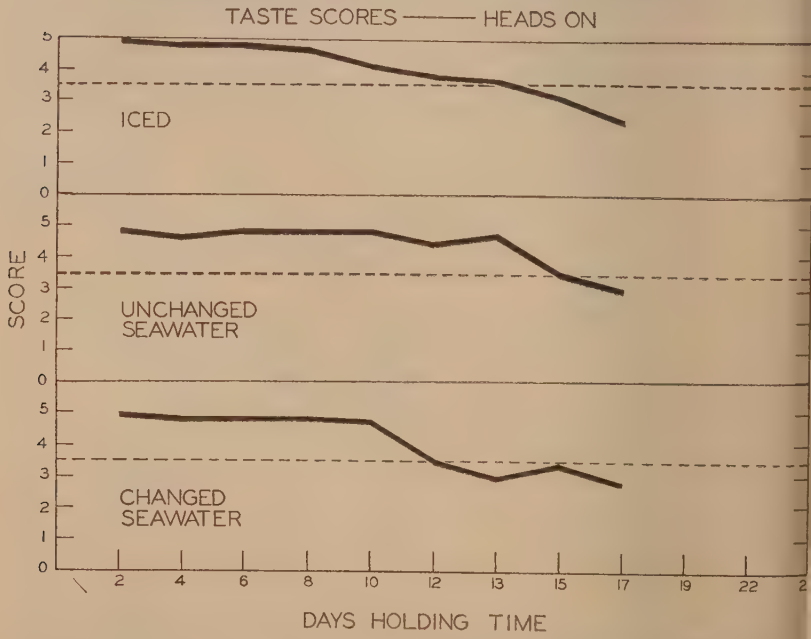

FIGURE 2. Taste scores of "heads-on" shrimp held on ice or in refrigerated seawater for 17 days. Broken lines indicate the arbitrary minimum level of acceptability (3.5).

be obtained by holding shrimp in refrigerated seawater than by the conventional icing method. (Figs. 2-5).

All samples of heads-on shrimp had a shorter storage life than heads-off samples of the same pair. This is shown by the lower heads-on scores for taste and odor. (Figs. 2-5).

The taste scores of the heads-on iced sample fell below the 3.5 level of acceptability on the 15th day of storage. The heads-off iced sample of the same paid did not fall below this level until the 17th day. (Figs. 2, 3). Taste scores of heads-on, changed and unchanged seawater samples fell below the level of acceptability on the 13th and 17th days respectively. (Fig. 2.) The corresponding heads-off samples were of "good" quality until the 19th and 24th days. (Fig. 3).

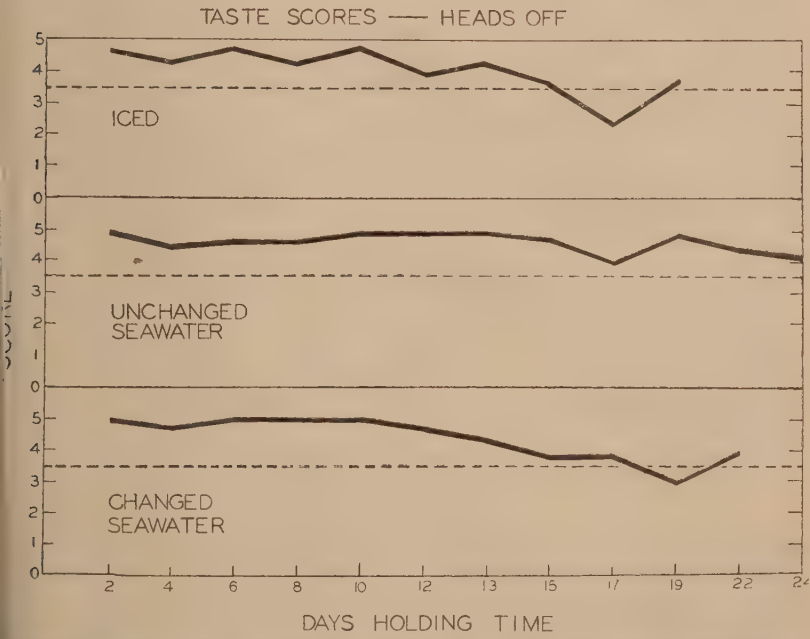

FIGURE 3. Taste scores of "heads-off" shrimp held on ice or in refrigerated seawater. Broken lines indicate the arbitrary minimum level of acceptability (3.5).

Odor scores of the heads-on iced sample fell below the level of acceptability on the 15th day of storage and continued this downward trend until the end of the experiment. (Fig. 4). The heads-off iced sample of this pair was rated 3.2 on the 12th day of storage. This however is an anomaly since the score on the following day was 4.2 and not until the 17th day did this sample fall below the 3.5 level of acceptability and continue its downward trend. (Fig. 5.). Odor scores rated the heads-on, changed and unchanged seawater samples objectionable on the 12th and 15th days respectively. (Fig. 4). The heads-off changed seawater sample was unacceptable on the 15th day, while the heads-off unchanged sample was not objectionable until the 24th and final day of the experiment. (Fig. 5).

There was no significant indication of black spot in any of the samples held in seawater. Black spot developed in a normal manner on the ice-held shrimp. In the heads-on sample black spot developed most rapidly in the heads of these shrimp. Since the heads were removed from this sample before being rated by the test panel this difference does not show in the rating scores. In comparing the scores of the black spot ratings on shrimp tails only, there seems to be no difference in the rate or amount of black spot developed on these two iced samples. (Table 2).

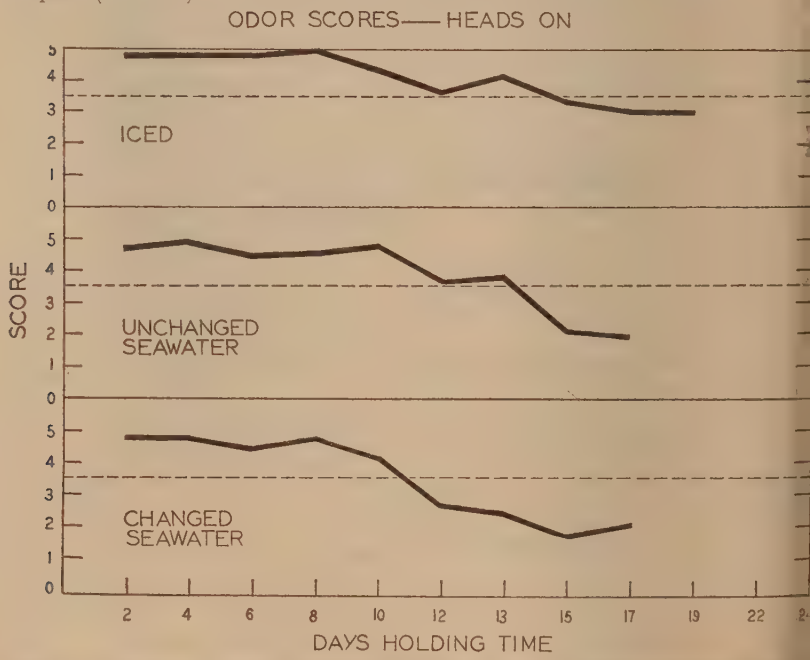

FIGURE 4. Odor scores of "heads-on" shrimp held on ice or in refrigerated seawater. Broken lines indicate the arbitrary minimum level of acceptability (3.5).

The headed sample held in unchanged seawater remained above the 3.5 level of acceptability in respect to taste, odor and black spot for 22 days. This was the best sample in the experiment. On the 24th day it fell below the acceptable level only in the quality of odor, which was rated 3.3 (Fig. 5). By contrast the iced samples fell below this level in one or more qualities by the 15th day. (Figs. 2-5).

Bacteriological tests were conducted on each day that organoleptic tests were made. It was anticipated that the numbers of bacteria in the seawater might increase with prolonged holding and that relative size of the bacterial population might give some clue as to the minimum holding period. Figure 6 shows the estimated numbers of bacteria per cubic centimeter of seawater, or drip from melting ice, at the various sampling days.

Bacterial counts on all samples showed either no increase throughout the experiment (Numbers 1, 4, 5, & 6) or slight increases (Numbers 2 & 3). The

fact that no large increases in bacterial counts occurred in the seawater would suggest that at the temperatures involved bacterial action is slight. Such a situation must necessarily prevail if shrimp are to retain their quality.

Shrimp held in the same seawater throughout the experiment kept better than those on which 15 per cent of the water was changed daily. The latter result was unexpected. It was anticipated that shrimp would keep better if part

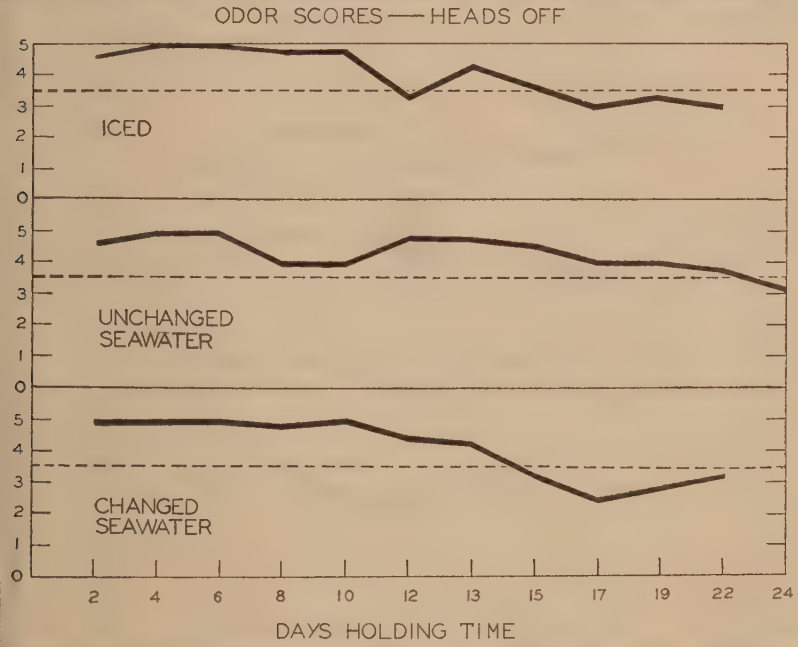

FIGURE 5. Odor scores of "heads-off" shrimp held on ice or in refrigerated seawater. Broken lines indicate the arbitrary minimum level of acceptability (3.5).

of the water containing fragments of shrimp, bacteria and dirt was replaced by clean water. Due to a temperature differential in the refrigeration unit the headed unchanged seawater sample was held 3.5°F. lower than the headed changed seawater sample. (Table 2). The comparison between these two samples was not considered conclusive inasmuch as the higher quality of the unchanged seawater sample could have been due to the lower holding temperatures.

To confirm these results, in later experiments the temperature was held constant while changed and unchanged seawater samples were compared. From this series of tests it would appear that nothing is to be gained, in terms of quality, by changing the seawater.

Following the first announcement of these results it was learned that several owners of shrimp boats had installed tanks for the purpose of holding shrimp in refrigerated seawater. Shrimp from the cargos of two of these vessels were rated by the test panel.. Although both samples were of marketable quality they were on the borderline of acceptability, according to Marine Laboratory standards. The lower quality was attributed to two factors. First, holding tem-

peratures of these shrimp ranged from 34° to 40° F., whereas recommended holding temperatures are between 28.5-30° F. In addition, both of these boats returned with shrimp, the oldest of which were 25 days. This is well beyond the recommended maximum holding period.

Insofar as could be determined these cargos of shrimp were marketed without difficulty. In judging their quality some buyers stated that their odor was objectionable.

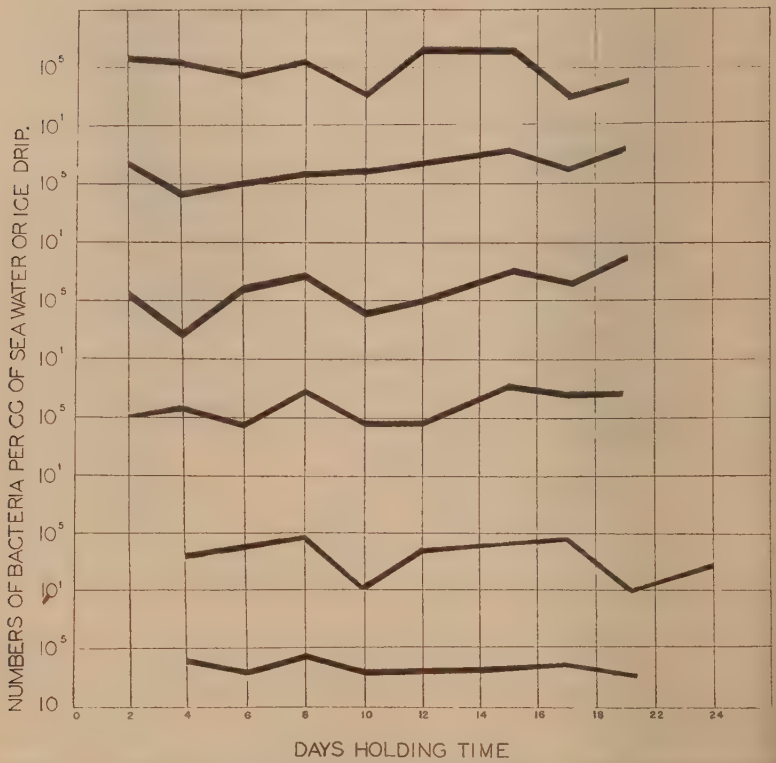

FIGURE 6. Graphical representation of the bacterial history of ice- and seawater-held shrimp. Sample No. 1, "heads-off" shrimp held in changed seawater; sample No. 2, "heads-on" shrimp held in changed seawater; sample No. 3, "heads-on" shrimp held in unchanged seawater; sample No. 4, "heads-off" shrimp held in unchanged seawater; sample No. 5, "heads-off" shrimp held in ice; sample No. 6, "heads-on" shrimp held in ice.

The odor ascribed to these shrimp had been noted in our experiments. Thorough washing partially eliminated it. Furthermore, there was no indication that the odor influenced the quality of the taste, according to ratings of the test panel. It was decided to investigate the odor question more fully.

The problem was first approached by further experimentation with the changing of various volumes of refrigerated sea water at regular intervals. Tables 3, 4 & 5 report the results of two separate experiments, each comparing

hrimp held in unchanged seawater with samples having part or all of the water hanged at intervals. Ten percent of the seawater on one sample was changed aily; on another sample 100 percent of the seawater was changed every third ay. Organoleptic tests were made comparing the quality of shrimp held in hanged and unchanged seawater. There was no marked difference in odor and ste among the samples,(Tables 3,4) again confirming previous results. How-ver, the changed seawater samples became sigificantly tougher upon holding r 21 days. (Table 5.).

Bacteriological tests were again made, in addition to organoleptic tests.

TABLE 3

Taste Scores—Heads Off

Maximum score: 5.0.

Days torage	Seawater Unchanged	Seawater 10% changed daily	Seawater Unchanged	Seawater 100% changed each 3rd day
	Average holding temperature °F			
	31.1	31.1	31.1	31.1
4	5.0	5.0	5.0	5.0
7	5.0	5.0	4.6	4.8
9	4.8	5.0	..	..
11	4.8	5.0	4.8	4.8
14	4.4	4.2	4.8	4.4
16	4.6	4.6	..	..
18	4.6	4.4	4.2	4.0
21	4.8	4.4	4.0	3.6
23	4.2	3.6	..	..
25	3.2	3.6	4.0	3.0
28	4.0	3.6	..	..
30	3.0	3.4	..	..

TABLE 4

Odor Scores—Heads Off

Maximum score: 5.0.

ays S rage	Seawater Unchanged	Seawater 10% changed daily	Seawater Unchanged	Seawater 100% changed each 3rd day
	Average holding temperature °F			
	31.1	31.1	31.1	31.1
4	5.0	5.0	5.0	5.0
7	5.0	5.0	4.8	5.0
9	5.0	5.0	..	..
1	4.6	4.8	4.6	4.6
4	5.0	4.6	4.6	4.8
6	4.8	4.8	..	..
8	4.8	4.8	4.8	4.6
1	4.8	5.0	4.6	4.8
3	3.4	3.8	..	..
5	3.8	3.8	4.0	4.2
8	4.6	4.4	..	..
0	3.2	4.8	..	..

TABLE 5

TOUGHNESS SCORES—HEADS OFF

MAXIMUM SCORE: 5.0.

Days Storage	Seawater Unchanged	Seawater 10% changed daily	Seawater Unchanged	Seawater 100% changed each 3rd day
	Average holding temperature °F			
	31.1	31.1	31.1	31.1
4	5.0	5.0	5.0	5.0
7	4.6	4.8	4.2	4.4
9	4.4	4.2	..	..
11	4.0	4.4	4.2	4.2
14	3.2	3.4	4.2	3.8
16	3.8	3.8	..	..
18	3.8	3.8	4.0	3.8
21	3.8	3.0	3.8	3.2
23	3.8	2.8	..	..
25	3.0	3.0	3.4	2.2
28	2.8	2.6		
30	2.8	3.0		

Table 6 shows the number of bacteria per cc. of seawater after various periods of storage. As may be seen from Table 6 the beginning of the rise in bacterial numbers on the 25 day does not coincide with the acceptability ratings of the organoleptic tests. Tables 3,4 depicting scores for taste and odor indicate the maximum storage time for seawater held shrimp is about 21 to 23 days.

Since changing the seawater did not retard the development of the undesirable odor, attempts were made to eliminate this factor by adding to the seawater, chemicals which inhibit bacterial activity.

TABLE 6

THOUSANDS OF BACTERIA PER CUBIC CENTIMETER OF SEAWATER

Days Storage	Average holding temperature °F. 31.1 Seawater Unchanged	31.1 Seawater 10% changed daily
4	1000.0	100.0
7	0.1	1.0
9	1.0	0.1
11	0.1	1.0
14	0.1	0.1
16	1.0	1.0
18	1.0	0.1
21	0.1	0.1
23	1.0	0.1
25	1.0	1.0
28	10.0	100.0
30	1000.0	10,000.0

Tests were made of the quality of shrimp held in untreated seawater to which sodium hypochlorite had been added in concentrations of 5, 10 and 20 parts per million (p.p.m.). The scores for odor show that no advantage i

gained in suppressing odor by the addition of sodium hypochlorite in the concentrations tested. (Table 8). Taste and toughness scores indicate minor variations in quality, the advantage being with the unchanged seawater sample (Tables 7-9). "Fram Kem" and "Perchloran" were also tried as bacteriostatic agents. "Fram Kem" (a mixture of sodium benzoate and fumaric acid) was used in concentrations of 500 p.p.m. and 1000 p.p.m.; Perchloran (70% calcium hyperchlorite) was tried in concentrations of 10 and 50 p.p.m.

The results indicate that no advantage is to be gained by the use of these concentrations of chemicals. (Tables 7-9).

TABLE 7

TASTE SCORES—HEADS OFF

MAXIMUM SCORE: 5.0

Days Storage	SEAWATER-HELD					SEAWATER-HELD			
	Unchanged	Plus 5ppm NaOCl	Plus 10ppm NaOCl	Plus 20ppm NaOCl	Unchanged	Plus 500 Fram Kem	Plus 1000 Fram Kem	Plus 10ppm $CaOCl_2$	Plus 50ppm $CaOCl_2$
	Average holding temperature °F								
	30.8	30.2	30.9	33.2	31.8	31.8	31.8	32.0	32.0
2	4.8	4.6	4.2	4.6	..	..	..		
5	4.2	4.8	4.6	4.4	..	..	..	..	..
6	..	..	..	..	4.6	..	..	4.4	4.6
7	..	..	..	..	4.6	4.8	4.6		
8	4.2	4.0	4.2	4.4	..	..	..	..	..
10	..	..	..	..	4.6	..	..	4.4	3.8
11	..	..	..	..	4.4	4.0	4.4		
12	4.4	4.4	4.0	3.8	..	..	..	..	..
13	..	..	..	..	3.4	..	..	4.2	4.2
14	..	..	..	..	3.8	3.8	4.0		
15	4.0	4.2	3.4	3.0	..				
17	..	..	..	..	3.4	..	..	3.4	3.6
18	..	..	..	..	4.0	3.6	3.8		
19	3.2	4.0	3.2	2.8	..				
20	..	..	..	..	4.0	..	..	3.0	3.0
21	..	..	..	..	4.0	2.8	3.6		
22	2.8	2.6	2.6	2.4	..	..	..	..	..
24	..	..	..	..	3.4	..	..	3.6	4.0
25	..	..	..	..	3.8	3.2	2.8		

At the recommended holding temperature of 28.5-30°F. the method of holding shrimp in refrigerated seawater shows several advantages over the conventional icing method.

1. Iced shrimp are not of acceptable quality after 15 days while seawater held shrimp may be kept for 21 days.

2. No measurable amount of black spot develops on shrimp held in refrigerated seawater.

3. Changing the seawater does not improve the quality of shrimp. Indications are that it toughens them.

TABLE 8

ODOR SCORES—HEADS OFF

MAXIMUM SCORE: 5.0

Days Storage	SEAWATER-HELD					SEAWATER-HELD			
	Unchanged	Plus 5ppm NaOCl	Plus 10ppm NaOCl	Plus 20ppm NaOCl	Unchanged	Plus 500 Fram Kem	Plus 1000 Fram Kem	Plus 10ppm $CaOCl_2$	Plus 50ppm $CaOCl_2$
	Average holding temperature °F								
	30.8	30.2	30.9	33.2	31.8	31.8	31.8	32.0	32.0
2	5.0	4.0	4.8	4.6					
5	5.0	4.6	4.4	4.2	..	..	..	..	
6	..	..	..	..	4.6	..	..	4.8	5.0
7	..	..	..	..	5.0	4.6	4.8	..	
8	4.6	5.0	5.0	4.4	..	..	..	..	..
10	..	..	..	..	5.0	..	..	4.6	4.4
11	..	..	..	..	4.6	4.6	5.0		
12	4.2	5.0	3.8	4.4	..	..	..	..	..
13	..	..	..	..	4.6	..	..	4.6	4.6
14	..	..	..	..	4.4	4.8	4.4		
15	4.2	4.6	3.6	3.8	..	..	..	..	..
17	..	..	..	..	4.6	..	..	4.2	4.6
18	..	..	..	..	4.4	4.2	4.4		
19	3.4	3.2	3.2	2.6	..	..	..	..	
20	..	..	..	..	4.4	..	..	4.6	4.4
21	..	..	..	..	4.2	4.2	4.2		
22	3.4	3.2	3.6	2.2					
24	..	..	..	..	3.8	..		3.8	2.8
25	..	..	..	..	3.8	3.6	2.8		

4. The quality of shrimp kept in various chemical solutions show no improvement over shrimp held in plain seawater.

5. Temperature is the most important factor in determining the success of this method. An average temperature of 28.5-30°F. should be maintained if possible; every degree of temperature higher than this will lower the quality of the shrimp and shorten the storage time.

6. In all methods of holding, shrimp with the heads removed kept better than those with the heads left on.

TABLE 9

TOUGHNESS SCORES—HEADS OFF

MAXIMUM SCORE: 5.0

Days Storage	SEAWATER-HELD				SEAWATER-HELD				
	Unchanged	Plus 5ppm NaOCl	Plus 10ppm NaOCl	Plus 20ppm NaOCl	Unchanged	Plus 500 Fram Kem	Plus 1000 Fram Kem	Plus 10ppm $CaOCl_2$	Plus 50ppm $CaOCl_2$
	Average holding temperature °F								
	30.8	30.2	30.9	33.2	31.8	31.8	31.8	32.0	32.0
2	4.8	4.8	4.6	4.8					
5	4.0	4.6	4.4	4.2					
6					4.6			4.4	4.2
7					4.4	4.4	4.2		
8	4.0	3.8	3.8	4.4					
10					4.0			4.0	3.2
11					3.6	3.8	3.8		
12	4.2	4.0	4.4	4.4					
13					3.8			4.0	3.0
14					3.8	3.4	3.8		
15	4.2	3.8	4.0	4.0					
17					3.0			3.2	3.8
18					4.2	3.6	3.6		
19	3.2	3.8	3.2	3.2					
20					3.8			3.0	2.6
21					3.6	2.8	3.2		
22	3.4	2.4	2.8	2.6					
24					3.0			3.4	3.8
25					3.0	2.8	2.4		

Practical Aspects of Shrimp Freezing

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Several thousand years ago a Chinese farmer accidently discovered the process of preserving food by cooking, or so says Charles Lamb in his "Dissertation on Roast Pig". The story says that the farmer's house burned, a suckling pig was caught in the fire and roasted; the farmer burned his fingers in trying to retrieve the pig, stuck his fingers in his mouth to relieve the burn, and thereby tasted the flavor of roast pig for the first time. The story further states that there was an epidemic of fires until it was found that pigs could be roasted without burning the house down.

The ancients of Rome depended on the spices of the Far East to preserve their food and to cover up the odor and taste of food already spoiled.

Several milleniums ago a snow and ice slide in Alaska entombed a prehistoric mammoth which stayed in its icy tomb until the early part of the 20th century, when it was uncovered by another slide disclosing it to a hunter's dog, who began to gnaw away on this ancient carcass. The dog's master noticed the strange meal the dog was having and tried eating some of the mammoth meat himself. The meat was found to be unspoiled but strong and dry; it was a poor freezing job but it did preserve the meat.

Mankind has searched for centuries to find better methods of preserving foods and many of the methods used resulted from accidents such as related in the foregoing incidents, whether these incidents be true or whether they be merely fables.

Freezing is only one of the methods of preserving foods, but it has been fairly well demonstrated that freezing retains more of the natural flavor of food than many of the other common methods. The technical reason for this fact is that the cellular structure of the food is less affected by freezing than nearly any other method of preservation.

Many of us members of the freezing industry have learned what we know about shrimp freezing by having experimented with various methods and procedures; some of us have learned through our pocket books that some methods were inadequate, to say the least. It is the personal opinion of the writer that there is little difference between freezing shrimp on plates or by a blast of cold air, providing the temperatures are similar. The larger the container in which the shrimp are frozen, the more affective the blast of air method becomes as compared to the plate method. Furthermore, the smaller the container the faster the shrimp will freeze. However, the smaller the container the more the labor cost involved in the operation. Theoretically, the best method would be to freeze each shrimp individually, and in fact, some of the processors are doing just that. However, we must keep in mind that costs should be kept as low as possible in order to obtain and maintain the largest number of consumers.

From our own experience, and from a consensus of technical data available, we have found that a temperature of 25 to 40 degrees below zero F., is a practical temperature at which to freeze shrimp. This temperature is low enough to freeze the shrimp so rapidly that the cellular breakdown is kept at a minimum. Theoretically, the lower the temperature the better the freezing

job, but again we must take economics into consideration. Our engineers tell us that the cost of lowering temperatures becomes progressively more expensive the lower it becomes. For example, it is considerably more expensive to lower the temperature one degree from minus 15 to minus 16 degrees than it is from plus 15 to plus 14 degrees.

Further experiments on our part have shown that shrimp will freeze at plus 10 degrees F., and if used within a period of three or four months will be found to be in a satisfactory condition. A greater amount of cellular breakdown occurs when the shrimp are frozen at plus 10 degrees than when frozen at lower temperatures, with the result that the shrimp becomes rancid in taste faster than when frozen at the recommended temperature.

Since freezing is only the first protective step in preserving shrimp by this method, we are also greatly concerned about further treatment. The frozen product must be protected from air while in storage, in transit, in the merchants show case, in the kitchen, and in fact all times after freezing, until it is consumed. If improper protection is given at any time during this period the product will reach the consumer in an inferior condition and all in the industry suffer.

The most important step after freezing is to protect the shrimp from air. Cold continually "hunts" for moisture and will remove it from the frozen shrimp unless the product is hermetically sealed. The protective material must be as nearly vapor-and moisture-proof as possible. One of the most popular methods of protecting shrimp is by glazing, which is the application of a thin film of frozen water, either by spraying a mist on the frozen product, or by immersing the product in cold water. A film of ice is formed which prevents the moisture being drawn from the shrimp during storage. If shrimp are stored over a long period it is essential that they be inspected periodically and reglazed before all of original glaze has disappeared. Under normal storage conditions, and with proper application of the glaze, shrimp should remain in a satisfactory condition for a period of eight to ten months.

Another method of protecting the shrimp from dehydration, which is popularly known as freezer burn, is to wrap the container with some filament of a moisture-and vapor-proof nature. Several different filaments now in use are cellophane, pliofilm, polyethylene, parchment, aluminum foil, and waxed paper. Each of these filaments is manufactured in many varieties and each variety has different properties which are not apparent to the eye. For example, there are said to be fifty odd types of cellophane alone, each with different properties, devised for many different uses. It is therefore imperative that the protective filament used be moisture- and vapor-proof, and cold resistant. A filament designed for wrapping fresh produce or vegetables is not suitable for shrimp, one of the desired characteristics of the filament produced for wrapping vegetables, is that it "breathes", allowing gases generated by the produce to escape from the package. The exact opposite is desired for frozen food protection. It is customary to use a filament for over-wrapping consumer packages because of the greater eye-appeal for the housewife. Glazing, on the other hand, is ordinarily used on the institutional package since it is more economical and eye appeal not so important.

The master carton in which the wrapped or glazed shrimp is placed offers further protection if it is properly constructed from suitable material. A corrugated carton is commonly used.

Maintenance of a low temperature is desirable at all times, while the product is in storage or in transit. Free circulation of cold air is imperative for the maintenance of low temperatures. If there should be a hinderance to the free flow of air a temperature differential of 20 to 25 degrees may be observed in a small room or trailer.

Our experiments with various types of shrimp indicate that there is very little difference in the freezing characteristics of shrimp, be they white, pink, red or brown.

Statistics show that an increasingly greater percentage of shrimp each year is being marketed peeled and de-veined, breaded, or cooked. It may well be that we may see the day when practically all of the shrimp will be sold in this manner. Just as few housewives now go to the poultry market for an undressed chicken, so may she sometime demand that she purchase all of her shrimp in prepared condition. Fortunately for the industry as a whole, shrimp in a prepared form lends itself readily to freezing. All of the freezing and protective procedures which apply to shrimp in the shell apply as readily to prepared shrimp.

The question of freezing, thawing, and refreezing of shrimp is of a somewhat controversial nature. Our experiments have satisfied us that it is entirely practical to thaw, process, and refreeze shrimp, if they are properly handled. It is our opinion that this factor has been extremely important in stabilizing and expanding the shrimp market. The breaders have been a boon to the shrimp industry. The demand for shrimp for breading has become so great that it cannot be met during periods of low production. It is imperative that the breaders have a constant source of supply for them to continue to operate, and it is the frozen stock of shrimp which carried them through periods of slack production. However, thawed shrimp will deteriorate more rapidly than shrimp which have not been frozen, and require more careful handling.

The cold storage industry is constantly seeking new and better methods to serve the shrimp industry. Competition will weed out those who are not alert and who fail to keep up with new developments. Freezing will not resurrect any spoiled shrimp but if this delicacy reaches the freezer in a fresh condition we will seal in its pleasant flavor by proper freezing methods.

WEDNESDAY—NOVEMBER 19

Chairman—Richard A. Kahn, Chief, Branch of Economics Facilities, Defense Fisheries Administration, Washington, D. C.

Fisheries in the Netherlands Antilles

Mr. Ph. van Gelderen
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Two years ago at this Institute the writer discussed the fisheries in and around Surinam. This paper deals with the fisheries in the Netherlands Antilles, which, like Surinam, are a part of the Kingdom of the Netherlands.

Although the Netherlands Antilles are surrounded by large sea areas and consequently could, under normal circumstances, make an important contribution to the world production of fish, it is nevertheless unfortunately a fact that there is no well organized fishing industry in this territory as yet.

The Netherlands Antilles consist of six islands. Three of these, Aruba, Curacao and Bonaire, belong to the Leeward Isles, close to Venezuela, whereas the other three, St. Martin (part of which is French), St. Eustacius and Saba belong to the Windward group. The latter group are about 500 miles northeast of the first group and in the area of the Trade Wind. The Leeward Isles, with a population of about 160,000 have good transportation facilities with the outside world, while the other group, with a population of about 3,600, is handicapped in this respect.

The conditions which prevail in these islands require mention since they are largely the cause of the very modest development of the fishery. Large oil refineries have been established on Curacao and Aruba partly as a consequence of the excellent port facilities available there. This industry has contributed largely to the prosperity of the Antilles. Since the oil industry needs many laborers and pays good wages, this industry has attracted a considerable part of the available labor, especially among the younger workers. This has resulted in a certain amount of neglect of agriculture and a decrease in the production of salt, which used to be an important export product. Furthermore, the number of those who have chosen fishing as their profession has become smaller and smaller. When a serious start was made toward developing the fishing industry, the labor problem immediately proved to be one of the largest obstacles. It seems peculiar that Dutchmen, who always have been seafarers, with fishing as a prominent trade, could not succeed in settling even sufficient skilled fishermen in the Antilles to give the native population training in fishing as it is carried out in the Netherlands. The fact is, however, that the fisherman, unlike other groups of the Dutch population, has for generations been tied to the place of his birth. He may carry out his profession far from home for some time, but sooner or later he wants to return to the old familiar place in his fatherland. Since the Netherlands Antilles have about 164,000 inhabitants in an area of 364 square miles (part of which is unfit for habitation) or about 450 inhabitants per square mile compared to about 50 persons per square mile in the U.S.A., there can be no question of large-scale immigration to supply labor for the fishing industry, at least for the time being.

In the past various Netherlands experts have studied the deposits at the bottom of the seas which surround the islands, the currents, and the plankton and have tried to determine whether these waters are sufficiently rich to support profitable exploitation of fishing locally. Among other things it was found that the peculiar topographical relationships between Curacao, Bonaire and the mainland cause subsurface countercurrents, opposite in direction to surface currents, in a kind of deep channel which extends far into the East along the coast of Venezuela. At the surface there are often sharp drops in the temperature of the water. These are, of course, very important in influencing the distribution of floating fish eggs and fish larvae, which are conducted through the Westerly surface current of the rich fishing waters—for instance along the North coast of Venezuela—towards the islands of the Netherlands Antilles. These currents, of course, are of great importance in determining the potential for fishing in these waters. There are large shallow areas and banks of a low and sandy coast around the islands, and shallow bays with a rich flora, and the Leeward Isles seem to be situated very favorably for a worthwhile development of fisheries. There are a number of deep grounds where fish appear to be plentiful.

Some remarks are in order at this point about the present condition of the fishing industry, on the question of whether any substantial improvements are to be expected in the next few years.

The fish supply in the islands is considered insufficient to satisfy existing demand there. Around Curacao, Aruba and Bonaire some shrimp are caught, but the quantity is scarcely sufficient for local needs. Dried shrimp in barrels and in tins are even imported from the United States.

St. Martin has an increasing export of fresh lobster which is shipped by plane, mostly to Curacao and Puerto Rico. Some shrimp are caught around St. Martin, but also in insufficient quantities, and this type of fishing is only possible during the rainy season.

In 1949 a fishing corporation at Willemstad started using a trawler of about 175 tons for deep sea fishing in the waters around Curacao. The results proved unsatisfactory. One of the reasons evidently was, paradoxically, the lack of sufficient market for the fish landed. In Curacao and Bonaire fish markets have now been established and the one in Curacao has been successful. The number of places where ice can be obtained for the preservation of fish, however, are very limited.

The following figures might be helpful to show the quantity of fish products necessary for the local population. In 1950 the import of fish to the islands of Curacao and Aruba amounted to about 4½ million pounds, that is, about 30 pounds per capita per year. Local fishing does not exceed 1.1 million pounds, or about 7 pounds per capita.

What are the possibilities of establishing a fishing industry? First of all it should be stated that the Information Service for the Prosperity Plan of the Netherlands Antilles is active in working out plans for a prosperous development of the fishing industry in the most economical manner. At present this industry is not keeping pace with the progress which is taking place elsewhere, even in underdeveloped countries. In a subtropical territory like the Netherlands Antilles one of the first requirements is the availablity of facilities for preserving the fish. The fact that salt is available in large quantities is helpful in this connection.

The processing of fish scrap might be developed. Lobster and shrimp fishing could undoubtedly be expanded considerably. In the past an experiment has been made with the smoking of a small saltwater fish, the masbargo, related to the mackerel family, which is sometimes found in large shoals near Bonaire. The experiment was done in Europe, because there was no suitable smoke house available at that time in the Netherlands Antilles, and presumably due to this the experiment failed. It is almost certain that if the processing had been done locally the outcome would have been different.

It may be expected that line fishing, for instance for red snappers (pargo) could be expanded. Red snappers are in great demand among the population. The growing of turtles and sponges undoubtedly offers possibilities. The shipping connections between the islands should be improved.

The economical development of the fisheries should be preceded by scientific investigations, which should show where the fishing can be done, in what way, and which catches may be expected. The groundwork for this problem has already been laid, but some studies must be made of the nature of the fishing grounds for immediate guidance to the fishermen.

The question now arises: In what way should the development be carried out? Although the results of the investigations made thus far suggest the possibility of a fair-sized and remunerative fishing industry around the Netherlands Antilles, the fact should not be ignored that it does not automatically follow that this expectation will be realized. A recent example is the case of the attempted development of fisheries around the Seychelles (a British group of islands Northeast of Madagascar). This project was recently stopped because, in spite of the rich fishing grounds reported by investigators, the result did not live up to predictions.

In underdeveloped countries where the population is not yet used to different varieties of fish, there is always danger of a lack of a market. Outlets must be established for the fish which are caught. If there are no such outlets, any development is doomed from the start. There are two approaches to this problem. One of these is that fishing grounds should not be exploited until there is a sufficient guarantee of sales for all products. The other holds that the fishery should be developed, after which markets will be found more or less automatically.

No doubt fishing vessels of the Caribbean countries will, in due time, fish where they have the chance of success, and it seems certain that the Netherlands Antilles will contribute its share to this development, thanks to the untiring efforts of the people of these islands and the foresight in this respect of the Government of the Netherlands Antilles.

Some Preliminary Observations Relative to a Study of the Marketing Problems of the Florida Fisheries

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Introduction. Although little research has been done on the economics of fisheries, especially in regard to regional or local problems, and although our marketing research on Florida fisheries problems is essentially an initial under-

taking, economic research must be intimately related and kept in due proportion to research in other fields important to our total knowledge about fisheries. For marketing research to be most fruitful in giving help with the marketing problems, research dealing with other aspects of fisheries needs to be not merely continued but to be carried out on a much more expanded basis. It is not useful to study the means of achieving the highest economic use of a resource if we do not know the quantity and quality of that resource which nature can supply. For example, plans to develop a more extensive market for mullet through advertising and improved marketing practices, which depend on the adoption of new methods of catch, will not result in the most economic use of resources if the new methods of catch either are not feasible or if increased catch will exhaust the supply of mullet. Ecologists indicate that at present we know little about the fisheries resources of the vast South Atlantic and Gulf areas. Thus, a key question is, what volume of catch is to underlie plans to improve the marketing and distribution of Florida fishery products? The answer to this depends not only on additional knowledge about factors determining the quantity and quality of the resource, but all factors entering into the economic and engineering feasibility of the employment of new methods of catch.

Because of the broad sweep of fisheries problems, it is desirable to bring to bear the knowledge gained from a number of diverse fields of investigation if the proper identification of the problems is to be made. For this reason, it is deemed important to this discussion to deal briefly with the research approach and method that appears appropriate to the search for problems in the fisheries industry.

Marketing research is usually oriented from the individual firm or industry point of view. It is one aspect of what may be called applied economic or business research. Applied economic or business research, from the firm or industry point of view, is carried out, in most cases, within a frame of reference somewhat as follows: Given the present business conditions, the present state of scientific and technical knowledge, and our existing type of economic organization, are individual firms and the industry as a whole using good marketing methods, producing the best product possible, organized and financed on a sound basis, and in general engaged in good business practices?

This view of the problem tends to direct attention only to those adjustments or changes in business practice that are consistent with the ownership or management interests of individual firms and, in some instances, groups of firms. A viewpoint circumscribed in this manner must deal realistically with the incentives to innovations in production and marketing. Laboratory demonstration of new or improved techniques developed by fisheries engineers, or of new findings by special technicians, ecologists or food chemists is not enough. A businessman normally will not invest his money in one type of enterprise if he has more profitable alternatives readily at hand. In fact, our preliminary examination of Florida fisheries reveals in some instances a process of disinvestment by operators who either find it expedient not to maintain equipment or find it desirable to withdraw gradually from boat operations.

Preliminary Observations About the Problems of Marketing Florida Fish. Our preliminary survey to discover the problems incident to the marketing of Florida fish has consisted of a review of available data and of interviews with wholesalers in many parts of the state. These interviews were carried out to obtain from those in the industry their view of the general marketing situation

nd related facts. These interviews in conjunction with other information obained to date form the basis for the following preliminary observations:

1. The individual producer (initial wholesaler), as a rule, is not identified with the product that he supplies to the consumer market; thus, bad practices in handling and shipping fish by any one producer tends to work to the detriment of the entire industry. There appears to be substantially no effort on the part of Florida producers, either individually or as a group, to create a consumer preference for Florida sea foods. The consumer has little to guide him in the form of known brand names or in the form of generally understood standards of quality to be associated with Florida sea foods.

2. With some exceptions, methods employed in catching, handling, and preparing Florida fish for shipment appear to have undergone little change in recent years, whereas many changes have been made in other areas. Wooden boxes and barrels continue as the major types of containers used in shipping.

3. The freezing and storing of excess fish as a means of combatting the over-supply problem of the producer has not proved profitable. Producers state that the cost of freezing and storing adds so appreciably to their total cost that it is difficult to sell the frozen product at a profit; and if the supply of fresh fish moving into the markets continues throughout the season at a high level, the producer alleges that he is almost certain to incur a sizable loss in the sale of his frozen fish.

4. High production costs place Florida fish at a competitive disadvantage with fish from other parts of the country as well as with other competitive products. In fact, frozen fish from other parts of the country are sold extensively in Florida retail markets. These frozen products are sold primarily by chain stores and super markets.

5. The desirably prompt sale of fish by a Florida wholesaler often depends on the availability of truck transportation. The high cost of shipment by railway express and the unsatisfactory nature of rail freight shipment has caused buyers generally to make truck shipment a condition of purchase. Some producers operate trucks, but there is widespread dependence on trucks operated by independent truckers, or in some cases by buyers. The variation in catch as well as a variation in the pattern of sales creates a problem in scheduling trucks to meet shipping requirements.Some truckers do follow a regular schedule but this does not provide an answer to the problem inasmuch as shipping needs do not conform to a regular schedule.

6. Although some producers sell a part of their fish through the Florida Fish Distributors, Inc., in Jacksonville, it is customary for all producers (initial wholesalers) to sell directly to wholesalers in the various consuming markets. Although many city wholesalers continually buy from certain producers, it is also customary for the city wholesalers to maintain relationships with numerous Florida producers. Because of this individual direct selling method, it is customary for the Florida producer to start making telephone calls to wholesale buyers as soon as he has fish to sell, and usually he will continue to make such calls until he has executed a sale. Thus, when fish are running and the producers have large quantities

of fish to sell, the city wholesalers are swamped with offers of fish from Florida producers. Under such conditions the bargaining position of the city wholesaler is very strong. It is reasonable to assume that the fear of incurring complete loss as a result of holding fish until it is not marketable may sometimes lead the Florida producer to sell at a loss because he has no acceptable alternative under present conditions. Not only is this an unsatisfactory marketing method because of the price effect, but also because the excessive use of the telephone, resulting in duplicated calls, adds a high cost to selling.

7. Although not uniformly a problem, many producers experience difficulty in maintaining a satisfactory supply of labor. The seasonal nature of the employment and the presence of more profitable job opportunities in other activities contribute to the problem. In addition to the regular seasonal unemployment, the fisherman is at times temporarily unemployed when the producers find it necessary to cut off fishermen due to temporary conditions of over-supply in the market. These conditions in the labor market work to the detriment of both the employer and the employee.

8. A number of Florida producers have expressed the opinion that it has become more profitable for them to buy fish from fishermen who operate their own boats than to operate boats and employ fishermen. This opinion has caused producers in some instances to decrease greatly the size of their boat operations and increase the size of their purchases from independent fishermen. Various types of arrangements have been made between fishermen and producers to finance boat operations. Although the change noted may be more profitable from the producer's point of view, it appears to be a concession to a marginal type of operation that offers little future opportunity for reduced operating costs.

The Role of Perspective in the Identification of Problems. Perspective is of such importance, especially in the social science field where cause and effect are so difficult to ascertain and where measurement is so difficult to achieve, that it is not amiss to make some further comment on perspective at this beginning stage of a marketing study in the field. It is not simple to direct applied research activities into the areas of greatest benefit or into the areas that will necessarily provide the greatest addition to knowledge, because this is limited by the close dependence of one area of knowledge on another. For example, the improvement of marketing methods may be limited by problems of production and what can be accomplished to solve these problems. At the last meeting of the Gulf and Caribbean Fisheries Institute, Dr. Harden F. Taylor dealt with the broad subject, "What Are the Major Problems of the Fisheries?" His very stimulating paper clearly revealed the importance of a proper perspective, and he effectively pointed out that incorrect assumptions as to what the problems are may lead readily to unfruitful results and misdirected efforts.

Viewing the matter in its broadest terms, Dr. Taylor stated the problem of fisheries as follows: "What can science do to enlarge the contribution of fisheries to wealth and welfare?" This is, indeed, a broad statement and actually the full import of its meaning requires interpretation or explanation. It appears desirable for all of us, whether we be social scientists or physical scientists, to keep within the focus of our research plans the contributions our research can make to human wealth and welfare. However, this broad guide or criterion is

not necessarily of much help in providing exact direction within various limited areas of applied research. For if we seek to direct our research efforts from too broad a point of origin, we encounter many unknowns and imponderables that we are unable to resolve in view of the present state of our understanding and knowledge. The essential point that the writer wishes to make is this: Although we should not lose sight of the broad objectives of science, or of society, it is pragmatically effective to operate on an interim basis with limited knowledge and within the framework of the established economic philosophy and economic system because that is what we must work with *now* even though greater knowledge or some improvements in the system might better promote science and social wealth and wellbeing.

That is why, as a point of origin in marketing research, we take the existing situation, and, within the framework of the market mechanism or the free enterprise system, seek to find the problems arising from the existing situation. Our question is usually this: What can the industry or the individual firms within the industry do to improve their profit or market position and in so doing contribute to higher incomes for all of those employed in the fisheries industry?

In the paper presented last year, Dr. Taylor directed attention to the role of a broad perspective to make clear that there are many elements to be considered in problem analyses and that a failure to recognize this may lead to misconceptions as to the nature of a problem. To illustrate how misconceptions as to the nature of a problem may influence activity in the field of science, he compares fisheries to agriculture. He states:

> Agriculture has always been regarded as a source of wealth to be promoted in efficiency and productivity by every possible means, while the fisheries have been considered to be in danger of exhaustion and not to be promoted in efficiency but to be protected, conserved, restricted, and hampered. The consequences, at least in part, of these two opposite public attitudes are easily seen in the comparative performances of fisheries and agriculture.

This statement makes it clear that Dr. Taylor attaches no small significance to the influence of the two public attitudes on the development of activity in the respective fields. However, Dr. Taylor also makes it clear later in his paper that public attitudes both in the matter of conservation and in the matter of promotion may be rather ineffective at times. In pointing to what he considers misdirected effort in connection with certain oyster programs, Dr. Taylor suggests that the failure to recognize economic forces has resulted in much unfruitful activity. He states:

> Now it is an article of economic faith that the pursuit of gain energizes business, that where the prospects of profit exist, business will find a way to produce, and if the prospects are dim or absent, the business will decline or die. It is also an article of faith that when the public demands something of which the supply diminishes, the price rises to the maximum point at which the total supply can be sold.

These two statements from Dr. Taylor's paper are quoted because they direct attention not only to the importance of perspective and to the many interrelated parts of a problem but also to the fact that the influences which he mentions may be variously effective under different circumstances. His statements as to the role of profits accord with the significant development and

growth of many types of enterprise that have been exploitive of natural resources, and there are indications that the attitude held by the general public that conservation and protection were in order did very little to hold back production resulting from the energizing influence of profits. On the other hand, the same public attitude would appear to have had the effect of removing the prospects of energizing profits by creating in the public mind false ideas which brought about measures hampering and restricting profitable operations in fisheries. Yet when steps were taken to increase the supply of oysters, Dr. Taylor points out that such steps do not appear to have been justified from an economic point of view. The complex of physical, economic, and social forces involved in fisheries problems suggests the difficulty of determining just how the various component parts of the problems should be brought together.

Although our economic faith in the pursuit of gain as a business energizer should be fully recognized, this faith may not enable us to say definitely that greater production will take place in the fisheries if it offers increased profit opportunities. There are a number of factors that condition the ease with which an industry can be entered or the ease with which a certain type of business activity can be started. It is also true that the ability to increase the size of a business organization may be limited even though it is clear to the owners that an increase in size would bring about additional profits. For example, those presently engaged in fisheries may not be able to take advantage of new engineering developments in fisheries if to do so requires large capital outlays. Or increased profit opportunities may still not be as attractive as real estate speculation or, possibly, investments in motor courts or even in for-hire sport-fishing boats. It is necessary to look at an economic situation and see the deterrents to increased productivity that are immediately effective even though one should not lose sight of the forces that may ultimately come to bear on the situation.

If we seek to discover problems solely from a long-run or a broad social point of view, it is easily possible that we may deal with many things that are of no immediate concern to the businessman or even to the citizen. A distinction is often made between "pure science" and "applied science." In "pure science" the scientist may seek no immediate practical knowledge. His interest is to further our knowledge without considering its immediate utility, whereas a scientist who is engaged in activity prompted by immediate problems may, for example, seek to find an answer to a situation confronting a particular area or a problem confronting a particular group of producers. It is evident that the problems of scientists with these different points of view may be essentially different, and it is also true that the scientist who seeks to cope with special problems incident to production may have an outlook entirely different from that of the businessman. Marketing research starts in the mire of a complex of existing imperfect situations and examines the economic effects of the state of technology, the conditions of organization, operation, and production, the existing capital investment in the enterprise, and the incentives to capital investment. Once the entire situation is examined in terms of its various functional characteristics and purposes, the market research should proceed principally with an industry and firm point of view. Thus, the market analyst is interested in the products produced and sold, the organization and structure of the industry, the relationship of the industry to other industries, the scope and character of the market served by the industry, the channels of distribution, the selling and advertising practices, and consumer attitudes.

In the main, the business viewpoint of the market analyst leads him to examine these various aspects of the fisheries activity against the background of the question: What can businessmen, individually, or as a group, do to improve their sales and profit position?

Preliminary Plans for Research. As has been noted, it is difficult to deal with many aspects of the problem of effectively marketing Florida sea foods until more is known about the potential yield of fisheries in waters accessible to Florida. How is the ecological system influenced by present practices? What would be the effect of extensively greater catches through the application of new techniques that are being developed by fisheries engineers? Biological scientists inform us that more needs to be known about the migratory habits of species, about populations, about acclimation and transplantation effects, about predatory habits of species, and about other things necessary to an understanding of the supply potential. These matters require extensive additional study. While it is clear that a more accurate appraisal of profit opportunities can be made by economists after the physical scientists have had the opportunity to study more thoroughly the Gulf and South Atlantic areas, it appears urgent to proceed with the preliminary study of problems of distribution and sale on the basis of the present imperfect biological knowledge.

Our present marketing research plans call for an analysis of the costs and prices of selected Florida sea-food products under present supply and catch conditions. In view of the Florida producers' apparently unfavorably cost-price position in the market, it appears desirable to look at the elements of cost incident to all phases of fishery operations. For example, if large red snapper sells in the New York wholesale market for 43 cents per pound, how much of this goes to the city wholesaler, to the trucker or carrier, to box and crate manufacturers, to icing services, to boat builders and equipment suppliers, to fishermen, and to producers? How do the cost components of the fisheries operations in Florida compare with those from other sections of the country? These are the types of questions to which we will seek answers. In 1949, the Fish and Wildlife Service figures show that the return to the Florida fisherman was 23 cents per pound, whereas the per pound return to fishermen in other states ranged from a low of 1.80 cents in Delaware to a high of 16.75 cents in Alabama. We need to know the significance of these figures from a cost point of view. If it costs $3.00 per box to ship fish by truck into the New York market and if the wooden container costs $1.00, are these costs such as to and in the way of effective competition with other producers? It is desirable consider questions such as these in the light of a detailed analysis of all the costs involved in the various operations that are necessary to an ultimate sale in the wholesale market.

For purposes of our cost and price study, sea foods have been divided into four main groups: (1) salt-water fish; (2) shrimps; (3) oysters; and (4) other sea foods. Our immediate plan is to give attention mainly to group one. However, to the extent that we find it feasible to collect information about all four groups, we will do so. Our reason for placing greater emphasis on group one at this stage of the analysis is that the salt-water scale fish seems to be the Florida sea food which presents the most difficult marketing problem under present conditions of competition.

Among the data we have examined to date are the landing statistics collected

through the cooperative effort of the University of Miami Marine Laboratory, the Fish and Wildlife Service of the Department of the Interior, and the Florida State Board of Conservation. These data clearly have broad utility as basic information for analysis by the economist, the ecologist, the engineer, and others. For example, we have taken these data and analyzed the catch by month, by area, by species as a means of seeing how these elements may influence sales, employment, operating costs, and related factors in local areas. A review of these data quickly shows a number of things that are significant to an economic appraisal of some of the effects of the seasonal variation in catch. The removal of menhaden, the principal non-food variety, from the volume figures on total catch completely changes the dominant features of the seasonal catch variation. On the other hand, when volume figures are converted into dollar returns to fishermen the picture of variation is again modified. These conditions of variation have significance to an analysis of the local, the county, and the state-wide marketing of sea foods. As we examine the costs in local areas and by counties, we will uncover cost differences and similarities that may form the basis for either or both individual and group action.

We also plan to explore certain aspects of both the cost and the marketing feasibility of freezing and storing. It is appropriate to examine carefully any economic limitations to doing in Florida what is being done in other parts of the country. Such data as are available on sales patterns, marketing practices, consumer preference, per capita consumption of sea foods, and other relevant data will be utilized.

In the analysis of prices we will examine the relationships between the prices paid to the fisherman, the initial wholesaler, the city wholesaler, and the retailer. Our preliminary inquiries to obtain data have not been too fruitful, but we feel that enough is available to engage at least in a pilot study analysis. The types of questions that arise here are: What are the seasonal characteristics of prices? How do these compare with competitive sea-food and non-sea-food products? (The price relationships in certain markets of processed fish, frozen fish, and fresh fish are a part of this question.) How does geographical location and accessibility of sea foods from different geographical locations influence prices? A first step in the more effective marketing of Florida sea foods could possibly be taken within the state itself, and thus we will give some attention to marketing practices within Florida.

Survey of Household Consumer Preferences for Fish and Shellfish with Particular Emphasis on the Southern Region

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A year ago the Economics and Cooperative Marketing Section of the Branch of Commercial Fisheries began working on the form of a questionnaire to be used in a national survey of United States households for the purpose of determining their fish and shellfish preferences. We were joined in this work

by experts from the firm of Alfred Politz Research, Inc., marketing research specialists, with whom the Fish and Wildlife Service had contracted to do the field work on this survey. Upon completion of the questionnaire in late September 1951, blank copies were distributed to over one hundred interviewers on the field staff of the research firm. In October, 1951, persons in over two thousand households all over the United States, both in rural and urban areas, were asked to supply information in detail about their fish and shellfish preferences. Since the work was confined to households no consideration is given in this study to fish and shellfish consumption preferences of the relatively smaller consumption groups such as restaurants, institutions, etc.

This paper describes some of the results of the survey which are particularly applicable to the South. There are two principal aspects in which the detail can be presented. The first is concerned with how consumers in the South answered the questions which were asked in the survey. The second principal aspect has to do with providing information concerning the replies of consumers in all areas to southern fish producers to aid them in marketing their products throughout the United States.

Before presenting the results of the survey a short discussion is in order on the statistical methods used, in order that the results could be considered to reflect the thinking of *all* the nation's households. The persons questioned were mostly housewives who were selected on an area-sampling basis. A stratified random sample was used, with 2473 households out of the nation's forty odd millions constituting the sample. In the sample every household in the United States had an equal chance of being selected, after a few special control factors had been exercised. These control factors were fixed limits, based on census or other available data, on the number of households in each area, the number of persons engaged in agriculture, the percent of homes with mechanical refrigeration, and the percent of women in the labor force. The sample with respect to these criteria, is in exact proportion with census or other universal data for these items already available. As a result, the replies from the 2473 households which contributed interviews can be used as being representative of the whole United States allowing a narrow margin of error.

This technique of sampling on a probability basis proved to be remarkably accurate in this survey. Initially there was doubt whether taking only 24 to 26 hundred households out of the 40 odd million households in the United States would provide a basis for estimating the fish and shellfish preferences of all those households. Several means were employed of checking the data from the survey when it came in from the field, and some interesting results were found.

1. The percentage of farm households in the sample is about the same as in the census records.
2. The numbers of households with different religions are in the same proportions as in the World Almanac.
3. The percentages of households belonging to different races are in close proportion to census records.
4. The species which were indicated as being used by the respondents correspond to the proportions in the production records of the Fish and Wildlife Service.
5. The proportion of purchases in super markets is in agreement with distribution data available from marketing research sources.

These facts provide confidence in the statistical data obtained, in spite of the small number of households which was used as the sample.

Some of the more interesting results of the survey with respect to household consumers in the South (geographical boundaries of which are shown in Figure 1.), may now be presented. The great majority of such households do not have a special day of the week on which to serve fresh or frozen fish or shellfish. This was found to be true generally throughout the nation but praticularly so in the South. Furthermore there is not a marked preference for seasons in which to serve these products.

REGIONAL BOUNDARIES FOR REGIONS COVERED IN SURVEY

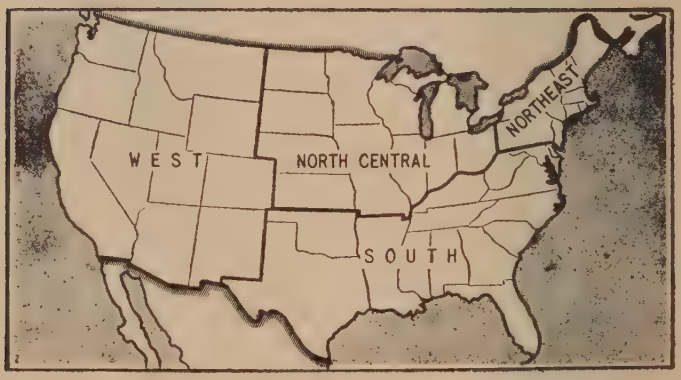

Fig. 1

Canned salmon and mackerel are two of the canned fish items which are used in relatively large volume in the South. Canned tuna is not used as much as in other areas of the country. Ocean perch is the main item of frozen fish consumption, fresh-water species are the main items of fresh fish consumption. For fresh, frozen, and canned shellfish, shrimp is the leading species.

The reader interested in more detail about preferences of southern consumers or in particulars about other sections of the country, should obtain Fishery Leaflets 407 & 408 which are Parts 1 & 2 of "Fish and Shellfish Preferences of Household Consumers."

Information from this study can be of benefit to Southern fish producers, by aiding them in marketing their products throughout all regions of the United States. An inspection of Table 1 will give the pattern of use for various types of fishery products found regionally and nationally in the study. Fish products of all types were used much more than shellfish products. The relatively smaller production of the latter is one reason for this. Of course it should be noted that a potential market for more shellfish exists if increased

TABLE 1

HOUSEHOLDS CONSUMING FISHERY PRODUCTS OCT. 1950-SEPT. 1951: BY REGIONS AND TYPE OF PRODUCT

ITEM	NORTH-EAST	NORTH CENTRAL	SOUTH	WEST	U.S.
FISH:			Percent		
Fresh	76.4	62.7	71.0	71.1	70.0
Frozen	51.8	62.2	42.9	51.9	52.2
Canned	79.4	79.9	71.5	83.2	77.7
Cured	29.1	21.0	9.9	23.3	20.3
SHELLFISH:					
Fresh	35.5	18.4	24.7	27.6	26.2
Frozen	19.4	22.7	14.3	23.6	19.4
Canned	29.8	17.2	10.8	29.8	20.4

SOURCE: *Fish and Shellfish Prefereences of Household Consumers—1951, Part II—Regional Summary,* Fishery Leaflet 408, Fish and Wildlife Service.

production can be obtained. Many households are not consumers of any type of shellfish products.

Other information to be drawn from Table 1 includes the fact that all types of fish and shellfish products, excepting fresh fish, are consumed in less-than-average quantities in the South. Fresh fish is desired by more households in this area than the national average. It is interesting to note that if the cost of serving fresh fish was the same as the cost of frozen fish, most households in this area (as in the entire nation) would prefer to serve fresh fish. The compartively low consumption of canned fish in the South poses some interesting questions and warrants scrutiny by the fishing industry to determine if price, type of product, type of pack or other factors are involved in this situation.

Shrimp, the fishery product of greatest value produced in the South, was the item used most by those households using fresh, frozen, and canned shellfish. This species is consumed in all regions of the country. (Table 2). However, in the Northeast region it will be observed that the use of fresh and frozen shrimp is lower than the average for the nation as a whole. In this area shrimp competes with scallops and lobsters, which are locally produced, for its share of consumer expenditures for shellfish. Any proposed market expansion on the part of the shrimp industry should note this situation.

With respect to fish, it should be noted from Table 2 that southern varieties do not sell well outside southern regions to any great exent. Mullet is consumed predominantly in the South. This also holds true for sea trout, red snappers and croakers, as well as for frozen fish.

Consumers had definite opinions as to why they preferred certain seafoods. For fresh seafoods taste was the dominant factor, while for frozen products ease of preparation was the principal reason cited, for preference.

The survey showed that most people can get the kind of fresh and frozen fish and shellfish they want. The super market is the principal source of fishery products. The distribution system for these fishery products as presently constituted seems to operate effectively, although it may be that inertia and close familiarity with the present distribution system are the reasons for this.

TABLE 2

Households Consuming South Atlantic and Gulf Fishery Products, Oct. 1950-Sept. 1951: By Regions and Products

ITEM	UNIT	NORTH-EAST	NORTH CENTRAL	SOUTH	WEST	U.S.
Households using:						
Fresh fish	No.	523	459	521	229	1732
Mullet	%	. . .	.7	13.8	. . .	4.3
Sea trout	%	2.5	.4	4.6	1.3	2.4
Red snapper	%	.2	.7	6.0	2.2	2.3
Croaker	%	.4	. . .	4.0	. . .	1.4
Frozen fish*	No.	355	855	315	167	1292
Mullet	%	. . .	.2	1.3	. . .	.4
Red snapper	%	.3	. . .	1.3	. . .	.4
Fresh shellfish*	No.	243	135	181	89	648
Shrimp	%	43.6	60.0	60.8	44.9	52.0
Oysters	%	12.3	31.1	21.5	10.1	18.5
Crabmeat	%	13.6	3.7	23.2	31.5	16.6
Frozen shellfish*	No.	133	166	105	76	480
Shrimp	%	54.1	83.1	77.1	76.3	72.0
Crabmeat	%	12.8	4.2	16.2	10.5	10.2
Oysters	%	2.3	10.8	2.9	3.9	5.6
Canned Shellfish*	No.	204	126	79	96	505
Shrimp	%	47.5	54.0	38.0	56.3	49.3
Crabmeat	%	40.7	17.5	34.2	40.6	33.8
Oysters	%	2.0	8.7	20.3	12.5	8.5

*Includes varieties from all regions.

Source: *Fish and Shellfish Prefereences of Household Consumers—1951, Part II—Regional Summary,* Fishery Leaflet 408, Fish and Wildlife Service.

Regardless of this, the present distribution system should constantly be subjected to improvement.

The major concern of this survey was to study the marketing of fresh and frozen fish, particularly groundfish fillets. As a result, in some parts of the study information was obtained only with respect to fresh fish, frozen fish, or both together. However, the information is of such a nature that it may be applied to the marketing of shellfish as well. This is particularly true for the questions on packaging.

Most people prefer a one-pound package and desire a long and flat shape. Apparently packages contain sufficient information on their wrappers to satisfy consumers. This includes the weight of the contents, whether it is raw or cooked, and the kind and cut of the product enclosed. Householders were not as definite in their opinions with respect to information on packages about recipes and the nutritive value of the contents but there is an indication that more information might be shown. It is worthy of note that in the South and North Central regions, where the relative use of all fish and shellfish is lower, most families fry fish or shellfish. In the other two areas where consumption is relatively greater, more baking, broiling, and boiling are done

Efforts to introduce more diverse cooking methods, through recipes or other means, might aid in raising the level of fish and shellfish consumption in the South and North Central areas.

In indicating their preference for wrapping materials, more householders liked cellophane because they can see the product. For many people of course, a cello wrapped product is the only type available.

Information was also obtained with respect to the purchase of frozen fish or shellfish by mail order. There is a relatively small business of this type, conducted predominantly in the North Central Region of the United States. From the replies to the questionnaire, it is evident that this type of business operates satisfactorily in that area. However, there was no evidence of any great desire for the extension of it to other areas of the country.

These results are the major ones of interest to Southern producers and distributors which have been obtained in analysis to date. The returns will be subjected to further analysis, particularly with respect to differences in preferences between the rural and urban households and households with different levels of income. Additional detailed information is also expected to be obtained with respect to packaging.

What Determines Fish Prices ?: An Approach to the Problem

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There are many factors which influence the prices of foods. While numerous studies of such factors as they relate to prices of agricultural commodities have been made, scientific approach to these economic phenomena as they pertain to fishery products is largely a virgin field[1]. This paper presents the results of preliminary studies of the effects of certain economic factors on prices of certain fishery products.

In considering this subject investigation was made of the inter-relationship of the volume of landings of ocean perch (rosefish) at Gloucester, Massachusetts, and the prices received by the fishermen at that port. A tabulation was made of the landings and corresponding prices received by fishermen at the ex-vessel level for each day during the 1948 calendar year (Table 1). An examination of these figures indicates that there is no significant correlation between the daily landings and the prices received by fishermen. It might be expected that changes in the volume of daily landings would be reflected in some lead or lag in price changes, but no evidence of such a pattern is discernible. There is similarly a lack of evidence of any correlation between the total landings and prices of ocean perch in 1948 during one week of each month (Table 2).

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[1] Of previous studies in this field may be mentioned Eunice M. Werner, "A Comparison of Controlled and Uncontrolled Fish Prices in New York City", Fisheries Market News, Vol. 6 No. 10; William C. Herrington, "Imported Fish: A Major New England Problem", Commercial Fisheries Review, Vol. 8, No. 2; and Harden F. Taylor, "Survey of Marine Fisheries of North Carolina", The University of North Carolina Press, 1951.

TABLE 1

INTERRELATION OF LANDINGS AND EX-VESSEL PRICES OF OCEAN PERCH (ROSEFISH) IN GLOUCESTER, 1948

Date 1948	Landings Thousands of Pounds	Prices ex-Vessel-in $ per cwt.
January		
8	13	6.00
9	326	5.50-6.50
12	440	6.25-7.75
13	44	6.00-7.35
14	126	7.05-7.10
15	32	6.90-8.00
16	. .	. . . . .
19	470	6.25-6.80
20	333	6.25-7.00
21	507	6.25-6.90
22	4	8.00
23	. .	. . . . .
26	403	6.25-7.25
27	340	6.50-6.65
28	55	6.75
29	60	6.80
30	135	6.50
February		
2	435	6.25-6.65
3	180	6.25
4	416	6.25-6.45
5	213	6.50-7.00
6	391	6.00-6.25
9	595	6.05-6.70
10	512	6.25-6.35
11	707	5.75-5.80
12	210	5.75
16	90	5.55
17	420	5.50-6.00
18	491	5.50
19	32	6.05-6.15
20	532	5.10-5.50
24	963	5.00-6.00
25	78	5.30-5.50
26	160	5.25
27	652	5.00-5.30
March		
1	1,250	4.50
2	530	4.75-5.05
3	20	5.00
5	637	4.50-5.15
8	598	4.50-5.40
9	54	5.30
10	207	5.00-5.50
11	390	5.00-5.30
12	420	5.00-5.10
15	1,055	5.00-5.25
16	353	5.00
17	245	5.00-5.30
18	233	5.00-5.25
19	786	4.50-4.75
22	1,135	4.25-4.90
23	426	4.60-4.75
24	730	4.25-4.55
25	366.5	4.00-4.25
26	565	4.00-4.20
29	1,297	3.75-4.05
30	1,062	3.75-4.05
31	694	3.75-4.05
April		
1	286	3.75-5.15
2	570	4.00-4.25
5	497	4.00-4.55
6	569	4.00-4.30
7	740	4.00-4.30
9	710	4.00-4.40
12	192	4.00-4.30
13	585	4.00-4.25
14	211	4.35-4.50
15	1,544	3.75-4.25
16	1,020	3.75-4.25
19	1,643	3.75
20	1,153	3.75-4.05
21	569	3.75-3.90
22	370	3.75-4.20
23	412	3.95-4.10
26	587	4.10-4.30
27	1,504	3.85-4.25
28	328	3.75-4.80
29	275	4.10
30	730	4.00-4.30
May		
3	1,507	3.75-4.15
4	1,343	3.75-3.85
5	1,807	3.75
6	1,157	3.75-4.05
7	1,102	3.75
10	845	3.75-4.15
11	550	3.75-4.20
12	513	3.75-4.30
13	1,284	3.75-3.90
14	1,840	3.75
17	2,249	3.50-3.75
18	1,175	3.75
19	560	3.75-3.80
20	1,277	3.75-4.15
21	712	3.80-4.20
24	1,704	3.75
25	1,242	3.75-3.95

Date 1948	Landings Thousands of Pounds	Prices ex-Vessel-in $ per cwt.
26	920	3.75
27	1,877	3.75
28	2,122	3.50-3.75
June		
1	1,941	3.00-3.25
2	1,600	3.25-3.50
3	1,125	3.25
4	1,733	3.00
7	1,825	3.00
8	270	3.30-3.45
9	2,217	3.00-3.25
10	2,408	3.00
11	851	3.00
14	938	3.25-3.45
16	25	. . . . .
July		
7	23	3.75
8	432	3.75-4.10
9	753	3.50-3.75
12	1,356	3.25-3.50
13	450	3.25-3.50
14	1,507	3.00-3.75
15	1,150	3.25
16	1,415	3.25
19	2,177	3.00
20	1,125	3.25-3.40
21	662	3.25-3.70
22	365	3.50-3.90
23	883	3.50-4.20
26	1,866	3.25-3.50
27	860	3.50-3.70
28	788	3.50-4.05
29	1,169	3.50-4.00
30	1,156	3.50-4.40
August		
2	1,885	3.25-3.65
3	1,538	3.25-4.00
4	840	3.30-3.35
5	814	3.40
6	1,343	3.00-3.50
9	890	3.50-4.00
10	662	4.00-4.30
11	998	3.75-4.15
12	680	4.00-4.50
13	1,139	3.85-4.55
16	2,180	3.50-4.00
17	889	3.75-4.35
18	690	4.25-4.65
19	670	4.55-4.90
20	465	4.50-4.75
23	1,402	4.25-4.95
24	1,114	4.25-4.95
25	1,323	4.25-4.80
26	935	4.50-4.95
27	1,403	4.50-5.10
30	1,735	4.25-4.90
31	970	4.75-5.65
September		
1	1,090	4.75-5.70
2	222	5.50-5.85
3	518	5.45-5.70
7	734	5.50-6.10
8	984	5.25-5.70
9	705	5.00-5.70
10	2,153	4.25-4.75
13	2,530	4.25-4.50
14	827	4.75-5.00
15	515	5.25-5.55
16	840	5.60-5.75
17	326	5.55-5.85
20	979	5.50-6.00
21	996	5.25-5.90
22	875	5.25-5.50
23	495	5.25-5.50
24	1,214	5.00-5.25
27	1,038	5.00-5.50
28	570	5.25-5.40
29	420	5.50-5.55
30	868	5.25-5.75
October		
1	1,182	4.90-5.30
4	1,887	4.75-5.15
5	811	5.00-5.35
6	687	5.00-5.50
7	,517	5.00-5.50
8	1,215	4.50-5.05
11	808	4.65-5.00
13	926	4.75-5.05
14	205	5.00-5.20
15	1,043	4.50-5.00
18	1,392	4.75-5.35
19	994	4.50-5.25
20	700	4.50-5.00
21	1,393	4.75-5.00
22	1,419	4.50- . . .
25	1,903	4.00-4.50
26	815	4.00-4.50
27	1,095	4.50-4.65
28	745	4.00-4.80
29	597	4.50-4.65
November		
1	271	4.00-4.80
2	420	4.50-5.00
3	617	4.50-4.60
4	725	4.50-4.80
5	527	4.50-4.90
8	2,419	4.00-4.25
9	715	4.00-4.05

Date 1948	Landings Thousands of Pounds	Prices ex-Vessel-in $ per cwt.	Date 1948	Landings Thousands of Pounds	Prices ex-Vessel-in $ per cwt.
10	1,122	4.00	6	840	4.25-5.50
12	890	4.00-4.30	7	1,221	4.25-4.50
15	711	4.00-4.15	8	440	4.25-4.40
16	395	4.00-4.10	9	429	4.25-4.66
17	530	4.00-4.30	10	333	4.25
18	183	4.45-5.05	13	712	4.00-4.75
19	396	4.25	14	730	4.00-4.10
22	847	4.00-4.30	15	465	4.25-4.50
23	1,167	3.75-4.00	16	183	4.00-4.50
24	1,265	4.00	17	515	4.00-4.35
26	1,185	4.00	20	1,121	4.25-5.55
29	880	4.00-4.10	21	597	4.25-4.60
30	325	4.00-4.50	22	218	3.20-4.30
December			23	9	5.00
2	315	4.15-4.50	24	177	4.00-4.25
3	190	4.00-4.55			

In order to minimize the fluctuations due solely to the changes of daily catch and prices, the data were then grouped to show landings and prices on Mondays throughout 1948, and averages of landings and prices on Mondays were computed for each month (Table 3). Data for Mondays were chosen for this study since the landings on other days were quite often so divergent as to preclude any correlation. By using the Monday landings and prices, averaged by months, a correlation pattern began to appear. A tabulation follows, based on the data in Table 3A, showing the relationship of these landings to prices, with the ranks in ascending order according to volume, and descending order according to price.

From the foregoing data it may be seen that there is, generally speaking, some relationship between averages of Monday landings and prices of ocean perch. Within certain limits, the catch goes up as the price goes down, and vice versa. In other words, there is a tendency for volume of catch and the price of the catch to vary inversely. However, a definite and reliable correlation is not indicated.

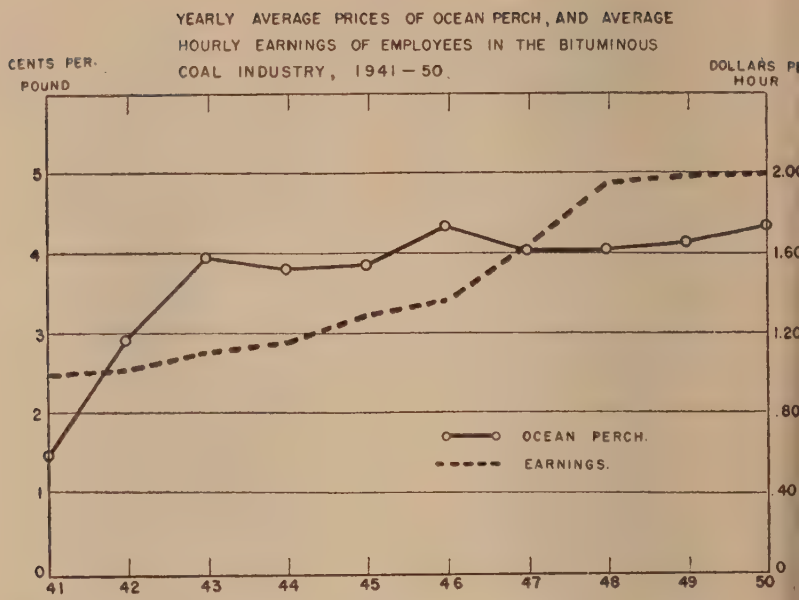
Obviously, there are factors other than volume of catch which influence the price of ocean perch at various times, as exemplified in the case of the catch and prices at Gloucester, Massachusetts. Certainly, volume of catch alone is not the sole determinant of the prices paid. This is evidenced by the fact that the catch of ocean perch dropped from 178,152,000 pounds in 1946 to 146,587,000 pounds in 1947 (17.7%), while the price decreased from $4.35 to $4.04 per cwt., instead of increasing, as would be expected if it were assumed that volume was the sole factor affecting price. On the other hand, the volume of catch rose from 146,587,000 pounds in 1947 to 238,096,000 pounds in 1948 (62.4%) (see Table 7), but instead of the expected decrease in prices, prices actually increased, although only from $4.04 to $4.05 per cwt. (see Table 4). However, when these price data are adjusted to take out the effects of inflation, there is a decrease from $0.025 for 1947 to $0.024 for

TABLE 2

INTERRELATION OF LANDINGS OF OCEAN PERCH (ROSEFISH) IN GLOUCESTER AND THE PRICES IN GLOUCESTER (ONE WEEK EACH MONTH—1948)

1948 Week beginning	Catch—000 lbs.	Prices ex-vessel $ per cwt.	Ratios
January 26			
Total	993		
Average (per day)	199	6.67	3.35
February 2			
Total	1,635		
Average	327	6.38	1.95
March 8			
Total	1,669		
Average	334	5.14	1.54
April 26			
Total	3,424		
Average	685	4.15	.61
May 10			
Total	5,032		
Average	1,006	3.90	.39
June 7			
Total	7,571		
Average	1,514	3.10	.20
July 12			
Total	5,878		
Average	1,176	3.32	.28
August 2			
Total	6,420		
Average	1,284	3.41	.27
September 13			
Total	5,038		
Average	1,008	5.21	.52
October 18			
Total	5,898		
Average	1,180	4.81	.41
November 1			
Total	2,560		
Average	512	4.61	.90
December 6			
Total	3,263		
Average	651	4.45	.68
Year			
Average	823	4.60	.56

FIGURE 1



1948. Thus, while the data on monthly averages of Monday landings and prices reveal some inverse relationship between landings and prices, this correlation generally is not highly significant.

At this point, it was considered that some light might be thrown on the subject by selecting a species of fish in which the volume of catch has remained fairly constant from year to year, and noting the price reactions for each year. Oysters were selected for this purpose, since during the 7-year period from 1942-1948, the volume of the catch ranged only from 73,139, 000 pounds to 80,038,000 pounds (Table 5). The range from low to high production in this period amounted to only 6,899,000 pounds, or less than 10 per cent, and, of course, the variation from year to year was even less than 10 per cent. Accordingly, if the assumption is valid that prices go up when volume goes down and vice-versa, it would be expected that little, if any, change in oyster prices would be seen. At least the conclusion that only about a 10 per cent fluctuation would have occurred in prices during the period seems justified. However, the data show practically a continuous rise in oyster prices, going from an average price of 15.7 cents per pound in 1942 to 36.5 cents in 1948. This represents an increase of 132 per cent in the price of oysters from 1942 to 1948, while the volume of production remained relatively stable.

On the basis of these figures, it is again obvious that factors other than volume of catch play an important part in determining the price of fish. As an approach to the solution, consideration was given to the varying supplies of money which consumers had available from wage payments or other sources, as expressed in the national per-capita income. As an example, suppose that the fishermen caught a normal volume of fish during a certain year, but some-

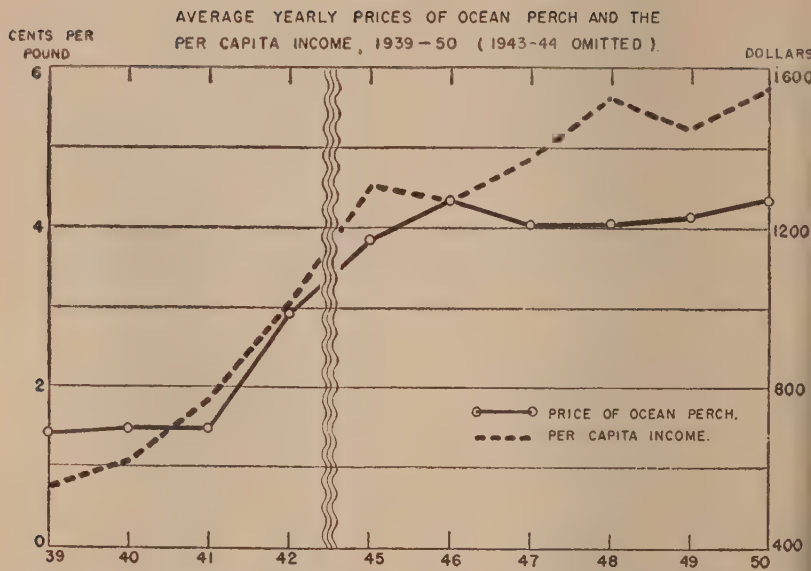
TABLE 3

INTERRELATION OF LANDINGS AND EX-VESSEL PRICES OF OCEAN PERCH (ROSEFISH) ON MONDAYS*, AT GLOUCESTER, 1948

Date	Landings	Prices	Rank[1]	
	Thousands of pounds	Dollars per cwt.	Landings	Prices
anuary				
12	440	7.00		
19	470	6.52		
26	403	6.75		
Avg.	438	6.92	1	1
ebruary				
2	435	6.45		
9	595	6.38		
16	495	5.52		
23	963	5.75		
Avg.	622	6.02	2	2
Iarch				
1	1,259	4.50		
8	598	4.95		
15	1,055	5.12		
22	1,135	4.57		
29	1,297	3.90		
Avg.	1,067	4,61	6	6
pril				
5	497	4.40		
12	192	4.15		
19	1,643	3.75		
26	587	4.20		
Avg.	730	4.12	3	8
Iay				
3	1,507	3.95		
10	845	3.95		
17	2,249	3.68		
24	1,704	3.75		
Avg.	1,576	3.83	10	10
ne				
1	1,941	3.12		
7	1,825	3.00		
14	938	3.60		
Avg.	1,568	3.24	9	12
July				
12	1,356	3.38		
19	2,177	3.00		
26	1,866	3.37		
Avg.	1,800	3.25	12	11
August				
2	1,885	3.45		
9	890	3.75		
16	2,180	3.75		
23	1,402	4.60		
30	1,735	4.58		
Avg.	1,618	4.03	11	9
Sept.				
7	734	5.80		
13	2,530	4.38		
20	979	5.75		
27	1,038	5.25		
Avg.	1,320	5.30	7	3
October				
4	1,887	4.95		
11	808	4.83		
18	1,392	5.05		
25	1,903	4.25		
Avg.	1,498	4.77	8	4
November				
1	271	4.40		
8	2,419	4.12		
15	711	4.08		
22	847	4.15		
29	880	4.05		
Avg.	1,026	4.16	5	7
December				
6	840	4.87		
13	712	4.38		
20	1,121	4.90		
Avg.	891	4.72	4	5
Grand Tot.	55,627	214.55		
Grand Avg.	1,184	4.56	6.7	6.7

[1] Landings in order of ascending rank and prices in order of descending rank.
*Note: Where Mondays fall on holidays, data for the following day are used.

FIGURE 2



thing occurred which appreciably reduced the consumers' supply of money. Theoretically, a drop in fish prices would result. The extent of the drop probably would depend upon the available supply of less expensive substitutes for fish. Similarly, when the consumers' supply of money increased, even with a large volume of fish catch, there would be a tendency for fishermen to realize higher prices for their catch. To appraise this theoretical assumption, the interrelationship between the price of ocean perch and the average hourly earnings of employees in the bituminous coal industry was studied for the period 1941 to 1950, inclusive (Table 6) (Figure 1). While there was an upward trend in both of sets of data, the coefficient of correlation is only .54, which is not significant.

Next, a correlation was made of the price of ocean perch and the national per capita income (adjusted for inflation) by dividing the price of ocean perch by the consumers' price index for the period 1941 to 1950 (Table 4). The data resulted in a coefficient of correlation of .47, which again is not significant. When the unadjusted data on per capita income and the price of ocean perch for the years 1941 to 1950 inclusive were studied, the coefficient of correlation was .90, which is a high degree of correlation (Table 7). An even more significant correlation of .965 resulted when the years 1943 and 1944 were dropped and 1939 and 1940 substituted (Table 8 and Figure 2). In 1943 and 1944 price controls were in effect on ocean perch, and, therefore, some distortion of the figures was likely, due to the failure of ocean perch prices to rise to the same extent as probably would have occurred in a free market.

In a similar study of the behavior of oyster prices in relation to per capita income, a correlation coefficient of .85 was computed for the period 1941-1948, inclusive (Table 5 and Figure 3) and .87 for the period 1939-1948 inclusive (Table 9). These correlation coefficients also are highly significant.

TABLE 3A

Average Monday landings by months Ascending order		Average Monday prices by months Descending order	Deviations of rank of prices from rank of landings
Rank	1000s of pounds		
1	438	1	0
2	622	2	0
3	730	8	+5
4	891	5	+1
5	1026	7	+2
6	1067	6	0
7	1320	3	—4
8	1498	4	—4
9	1568	12	+3
10	1576	10	0
11	1618	9	—2
12	1800	11	—1
Average	1184	$4.56	

The data were rearranged to show the rank of prices in exact order:

Average Monday prices by months Ascending order		Average Monday landings by months Descending order	Deviations of rank of prices from rank of landings
Rank	Price per cwt.		
1	$6.92	1	0
2	6.02	2	0
3	5.30	7	+4
4	4.77	8	+4
5	4.72	4	—1
6	4.61	6	0
7	4.16	5	—2
8	4.12	3	—5
9	4.03	11	+2
10	3.83	10	0
11	3.25	12	+1
12	3.24	9	—3
Average	4.56	1184 (lbs.)	

Next, cod and haddock were studied. A correlation was made between had-ock prices for the years 1939 to 1950 (omitting 1943, 1944 and 1945), eflated by the wholesale food price index and the disposable personal income, eflated by the consumers' price index. This correlation results in a coefficient f correlation of .52, which indicates some relationship but which is not high nough to be significant (Table 10, D). Another correlation was made etween cod prices for the years 1939 to 1950 (omitting 1943, 1944 and 945) and the disposable personal income, both deflated by the consumers' rice index. The result of the correlation with respect to cod is .84 (Table), C). However, it was ascertained that a highly significant correlation sulted when both cod and haddock prices were correlated with disposable ersonal income, both unadjusted, for the same period, 1939 to 1950, omitting

the years from 1943 to 1945, inclusive, since price controls were in effect during 1943 and 1944, and part of 1945. A correlation coefficient of .96 was obtained for both cod and haddock (Table 10, A and B). These high correlations showed that cod and haddock prices varied significantly with the amounts of disposable personal income available to the public in the years studied.

FIGURE 3

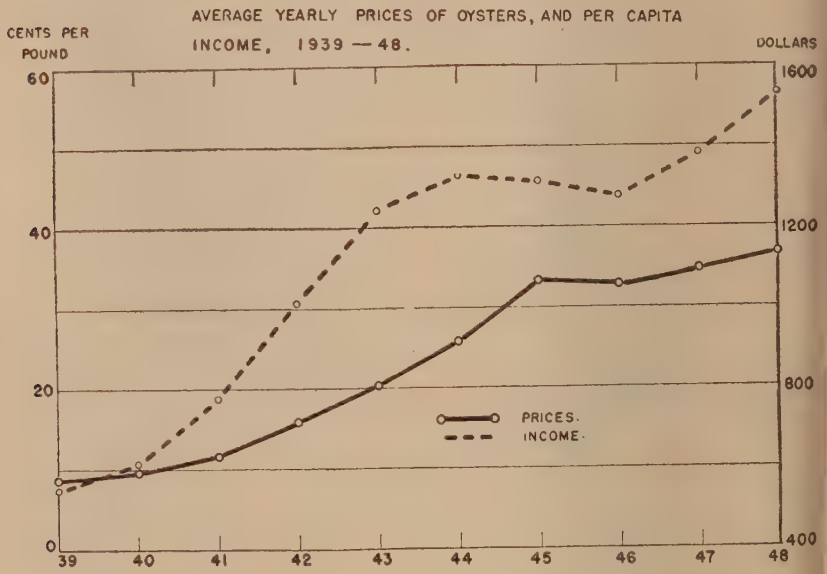


TABLE 4

INTERRELATION OF EX-VESSEL PRICES OF OCEAN PERCH (ROSEFISH) AND NATIONAL PER CAPITA INCOME, 1941-1950, PRICES FACTUAL AND ADJUSTED FOR INFLATION

Year	National Per Capita Income	Av. Price Ocean Perch (Per cwt.)	Consumers Price Index All Items (1935-39 = 100)	Av. Price of Ocean Perch (Divided by Consumers' Price Index) (Per cwt.)
1941	$ 779	$1.49	105.2	$0.014
1942	1,018	2.93	116.5	.025
1943	1,243	3.97	123.6	.032
1944	1,331	3.81	125.5	.030
1945	1,309	3.84	128.4	.030
1946	1,277	4.35	139.3	.031
1947	1,380	4.04	159.2	.025
1948	1,525	4.05	171.2	.024
1949	1,453	4.14	169.1	.024
1950	1,556	4.35	170.6	.025

TABLE 5

INTERRELATION OF PRICES OF OYSTERS AND NATIONAL PER CAPITA INCOME 1941-1948

Year	National Income (Billions)	Population (Thousands)	National Per Capita Income	Oysters		
				Catch (Thous. of lbs.)	Value (Thous. of $)	Av. Price per lb.
1941	$103.8	133,203	$ 779	88,956	$10,108	$.114
1942	137.1	134,665	1,018	75,414	11,805	.157
1943	169.7	136,497	1,243	73,139	14,751	.202
1944	183.8	138,083	1,331	74,656	19,288	.258
1945	182.7	139,586	1,309	75,655	25,147	.332
1946	180.3	141,235	1,277	80,038	26,080	.326
1947	198.7	144,024	1,380	79,895	27,568	.345
1948	223.5	146,571	1,525	78,369	28,619	.365

TABLE 6

INTERRELATION OF EX-VESSEL—PRICES OF OCEAN PERCH (ROSEFISH) AND AVERAGE HOURLY EARNINGS IN THE BITUMINOUS COAL INDUSTRY 1941-1950

Year	Hourly Wages	Price Cwt. Ocean Perch
1941	$ .993	$1.49
1942	1.059	2.93
1943	1.139	3.97
1944	1.186	3.81
1945	1.240	3.84
1946	1.401	4.35
1947	1.636	4.04
1948	1.898	4.05
1949	1.941	4.14
1950	2.000	4.35

TABLE 7

INTERRELATION OF EX-VESSEL PRICES OF OCEAN PERCH (ROSEFISH) AND NATIONAL PER CAPITA INCOME, 1941-1950

Year	National Income (Billions)	Population (Thousands)	National Per Capita Income	Perch		
				Catch (Thous. of lbs.)	Value (Thous. of $)	Av. Price per cwt.
1941	$103.8	133,203	$ 779	85,206	$ 1,272	$1.49
1942	137.1	134,665	1,018	128,107	3,755	2.93
1943	169.7	136,497	1,243	114,744	4,557	3.97
1944	183.8	138,083	1,331	120,216	4,582	3.81
1945	182.7	139,586	1,309	131,834	5,066	3.84
1946	180.3	141,235	1,277	178,152	7,749	4.35
1947	198.7	144,024	1,380	146,587	5,925	4.04
1948	223.5	146,571	1,525	238,096	9,647	4.05
1949	216.8	149,215	1,453	237,000	9,819	4.14
1950	236.2	151,772	1,556	208,000	9,047	4.35

TABLE 8

Interrelation of Ex-Vessel Prices of Ocean Perch (Redfish) and National Per Capita Income, Certain Years, 1939-1950

Year	National Per Capita Income	Average Price of Ocean Perch Per Cwt.
1939	$ 554.00	$1.41
1940	616.00	1.49
1941	779.00	1.49
1942	1,018.00	2.93
1945	1,309.00	3.84
1946	1,277.00	4.35
1947	1,380.00	4.04
1948	1,525.00	4.05
1949	1,453.00	4.14
1950	1,556.00	4.35

TABLE 9

Interrelation of Prices of Oysters and National Per Capita Income, 1939-1948

Year	National Per Capita Income	Average Price of Oysters Per Pound
1939	$ 554.00	$.088
1940	616.00	.095
1941	779.00	.114
1942	1,018.00	.157
1943	1,243.00	.202
1944	1,331.00	.258
1945	1,309.00	.332
1946	1,277.00	.326
1947	1,380.00	.345
1948	1,525.00	.365

TABLE 10

Interrelation of Ex-Vessel Prices of Codfish and Haddock and Disposable Personal Income, 1939-1950

A

Year	Codfish Price Per Pound (Cents)	Disposable Personal Income (Billion Dollars)
1939	2.2	70
1940	2.9	76
1941	3.0	92
1942	5.2	117
1946	6.5	159
1947	5.7	169
1948	6.3	188
1949	6.6	187
1950	6.9	200
Average —	5.0	139.8

B

Year	Haddock Price Per Pound (Cents)	Disposable Personal Income (Billion Dollars)
1939	2.5	70
1940	3.3	76
1941	3.3	92
1942	6.0	117
1946	8.4	159
1947	6.9	169
1948	8.0	188
1949	7.8	187
1950	8.5	200
Average —	6.1	139.8

C

Year	Codfish Prices Deflated By Consumers' Price Index (Cents)	Disposable Personal Income Deflated by Consumers' Price Index (Billion Dollars)
1939	2.2	70
1940	2.9	76
1941	2.8	87
1942	4.5	100
1946	4.7	114
1947	3.6	106
1948	3.7	110
1949	3.9	111
1950	4.0	117
Average —	3.6	99

D

Year	Haddock Prices Deflated By Wholesale Food Index (Cents)	Disposal Personal Income Deflated by Consumers' Price Index (Billion Dollars)
1939	2.3	70
1940	3.0	76
1941	2.8	87
1942	4.2	100
1946	4.1	114
1947	2.9	106
1948	3.0	110
1949	3.3	111
1950	3.4	117
Average —	3.2	99

In summary, these preliminary studies showed that, for the commodities and periods reviewed:

There was little or no correlation between

(1) Daily landings and prices of ocean perch at Gloucester, Massachusetts, during 1948.

(2) Weekly landings and prices of ocean perch at Gloucester, Massachusetts, during 1948.

(3) Annual domestic production and prices of oysters during the years 1942-1948, inclusive.

There was limited correlation between

(1) Monday landings and prices of ocean perch (averaged by months) at Gloucester, Massachusetts, during 1948.

(2) Average annual prices of ocean perch at Gloucester, Massachusetts, and average hourly earnings in the bituminous coal industry for the years 1941-1950 inclusive.

(3) Average annual prices of ocean perch at Gloucester, Massachusetts, and national per-capita income (adjusted for inflation) for the years 1941-1950 inclusive.

(4) Average annual prices of haddock (deflated by the wholesale food price index) and the disposable personal income (deflated by the consumers' price index) for the years 1939-1950, omitting 1943, 1944 and 1945.

There was a high degree of correlation between

(1) Average annual prices of ocean perch at Gloucester, Massachusetts and the unadjusted national per capita income for the years 1941-1950, inclusive; and for the years 1939-1950, omitting 1943 and 1944.

(2) Average annual prices of oysters and unadjusted national per capita income for the years 1941-1948, inclusive; and 1939-1948, inclusive.

(3) Average annual prices of cod and the disposable personal income (both deflated by the consumers' price index) for the years 1939-1943, inclusive; and 1946-1950, inclusive.

(4) Average annual price of cod and disposable personal income (both unadjusted) for the years 1939-1950, omitting 1943, 1944, and 1945.

(5) Average annual prices of haddock and disposable personal income (both unadjusted) for the years 1939-1950, omitting 1943, 1944, and 1945.

The Importance of the "Exempt Truck" to the Fisheries Industry

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One of the many factors of importance to the fisheries industry is distribution. One of the principal aspects of distribution pertains to the charges assessed and the quality of transportation services. One of the principal factors affecting transportation costs relates to the exemption of fishery products, from the provisions of the Interstate Commerce Act, particularly with reference to Section 203 (b)(6) of what is now Part 2 of that Act. Agricultural products, as described in Section 207 of the Agricultural Marketing Act of 1946, include fishery products. Because of this statute the Department of Agriculture has participated in numerous cases before the transportation regulatory agencies and Senate Committees to assist the fisheries industry.

There are four general types of motor highway operations. Common carriers operate between specified points on more or less regular trips. Contract carriers, by individual agreement, operate on a job basis. Private carriers, which have become the most numerous, are those engaged in transporting goods of the owners. Then there is the "exempt carrier," with which you are most directly concerned.

The fish and shellfish "crop" is extremely perishable and must be marketed immediately. Actual marketing is largely accomplished by wholesale distributors located at points of landings. The volume of fish and shellfish produced varies greatly. It cannot be anticipated or predicted, either as to quantity or time of landing. It varies from day to day, from a few thousand pounds to several hundred thousand pounds. However, small or large, the catch must be moved to markets promptly, regardless of time of day or night, week days, Sundays, or holidays, and to whatever markets consumer demand dictates. Much of this movement to market depends upon motor truck transportation. As a matter of fact, many inland towns and hamlets can be reached *only* by motor trucks.

In less than 50 years the rural highways have increased from approximately 1 million miles to 3 million miles, and about 500,000 miles have been paved or surfaced. These highways, plus new developments in electrification and refrigeration, mean an expanded opportunity to serve an ever increasing number of small markets. The Interstate Commerce Act contains a reference to the pertinency of developing highway transportation. In our efforts to preserve highway transportation, but more especially exempt trucks, we occupy tenable ground—but nothing should be lost by complacency or default.

The Motor Carrier Act has placed interstate motor common carriers under the full range of regulations, that is, requiring certificates of convenience and necessity, circumscribed routes, territory, types of traffic, rigidity of rates, uniform accounting, safety, and other rules. Regulation of motor vehicles operating as public carriers in transporting the basic agricultural (exempt) commodities, including fish and shellfish, is subject only to the safety requirements. Section 203 with reference to exclusions reads as follows:

"Motor vehicles used in carrying property consisting of ordinary livestock, fish (including shellfish), or agricultural commodities (not including manufactured products thereof), if such motor vehicles are not used in carrying any other property, or passengers, for compensation."

The Motor Carrier Act has been controversial ever since it was placed on the statute books. The I.C.C. has made some rulings that have been modified later—following review by the courts (see I.C.C. vs. Love—77 Fed. Supp. 63, 172 F. 2d 224). The crux of the difficulty lies in the translation of Section 203 (b) (6) by the Commission; the intent of the sponsors of this section and the interpretation of shippers. The final solution may depend upon: (1) judicial and inflexible determination by the United States Supreme Court; (2) by the passage of clarifying legislation; or, (3) a change in policy by the I.C.C.

Motor common carriers have imposed limitations as to routes or territory. A vast number of motor common carrier certificates exclude permission to haul livestock, fish, and seafood.

Thus, a great many of the certificated common carriers have relieved themselves of any obligation to perform the transportation service peculiar to the needs of agriculture and the fisheries industry.

It is very difficult for a trucking company to acquire an operating authority. Last spring, Congress was told that the I.C.C.'s Bureau of Motor Carriers had a backlog of more than 1,800 appeals for operating authority. The number has now grown to 2,200 and is still increasing.

Loss of the highly specialized transportation service presently utilized would reduce the number and choice of markets now available to the fisheries industry.

Most fish and shellfish shipments move in less-than-carload quantities. The industry, therefore, is greatly interested in the perpetuation of the Railway Express Agency, which, with its predecessor companies, made a definite pioneering contribution in the development of seafood markets throughout the country. It is also interested in obtaining lower rates and better services from the Railway Express Agency. The upward spiraling of express rates and charges has continued all through the past five years. The National Fisheries Institute, the Department of Agriculture and the Fish and Wildlife Service, have joined in protesting these rate expansions before the Interstate Commerce Commission.

Because of reported rising costs the Agency was granted an increase rate of 6 cents per shipment on February 28, 1952. Other attempts to increase express charges are now pending.

The Defense Transport Administrator on January 30, 1952, when addressing the annual convention of the United Fresh Fruit and Vegetable Association, said:

"There has been a steadily decreasing volume of express business during the past five years, and a steady increase in express rates. In 1946, the Railway Express Agency handled some 231 million less-carload shipments. The shocking traffic forecast for its 1952 operation is a maximum of 75 million less-carload shipments . . . If the railroads do not intend to renew the Express contract, they should not let their offspring die a lingering death waiting for the contract expiration in February 1954."

In its decision of June 19, 1951, the Interstate Commerce Commission made the following observation:

"The record indicates that express service in the recent past has been inferior to that of years ago in that it has become slower, delays in transit are encountered more often, pick-up and delivery service is often inadequate, and much inconvenience has been caused by the establishment of the 40-hour week for the respondent's employees."

Another item working against the improvement of the express services is the actual and potential abandonment of passenger trains because of deficits for 1951. The deficit was 681 million—dissipating 42 percent of the freight profits.

Should the Express Agency cease to function, or even curtail its services, then the retention of the exempt truck becomes all the more important to the industry as a means of keeping minimum charges.

Following the Love court case, previously referred to, which included the prohibition by the I.C.C. of headed shrimp being shipped as an exempt commodity, the Commission (52 MCC 576) adopted the following much broader and more suitable description in defining the meaning of the words "fish (including shellfish)" as used in Section 203 (b) (6):

"We find that the term 'fish (including shellfish)', as used in Section 203(b)(6) of the Interstate Commerce Act means frozen, quick frozen, and unfrozen fish and shellfish in the various forms in which it is shipped, such as live fish, fish in the round, beheaded and gutted fish, filleted fish, beheaded shrimp, and oysters, clams, crabs and lobsters, with or without shells, including crab meat and lobster meat, but excluding fish and shellfish in hermetically sealed containers and fish and shellfish which have been otherwise treated for preserving such as smoked, salted, pickled, spiced, corned, or kippered."

This ruling is now in effect.

On February 26, 1951, the I.C.C., in conformity with an appellate court decision (I.C.C. vs. Service Trucking Co., No. 10255, Third Circuit United States Court of Appeals), announced that fully regulated certificated motor carriers could utilize a motor vehicle loaded only with exempt commodities, without regard to the certificate and rate provisions of the Act.

Nevertheless, certain of these certificated carriers are endeavoring to amend the statute which would restrict the movement of fish over the highways. They perhaps contend, should exemptions be cancelled they would continue to haul the tonnage at higher tariff rates. They have given little thought to the prospect of losing the entire tonnage.

The Interstate Commerce Commission, on March 11, 1952, offered the Senate Committee a proposal relating to exempt fish shipments in the first movement from point of production to point of sale by the producer. The point of production in its proposal means wharves or other landing places at which fishermen debark their catch. The point of first sale shall not be deemed to include point of production.

In a Senate Committee hearing held last March, witnesses Hodges and Persaggi, representing the National Fisheries Institute, presented comprehensive and convincing testimony in opposition to S.2357 to restrict agricultural fish exemptions, and S.2362 arbitrarily designed to exclude trip-leasing.

Such legislation will likely be reintroduced at the next session of Congress.

The aforementioned bills were inter-related. The passage of S.2362, while referring to trip leasing, would largely nullify the good attached to the exemption clause of the Motor Carrier Act if passed.

An amended, S.2357 was actually passed at the last session of Congress but instead of diminishing the exemption clause, as originally intended, "horticultural commodities" were included within the term of agricultural commodities as exempt.

"The Traffic World" in its July 12, 1952, issue, in part, said:

> "The Eastern Railroad Presidents' Conference went on record July 10, advocating certain changes in the Interstate Commerce Act. Two of the items read as follows:
>
> "That contract carriers by motor, water and air shall be required to file, adhere to, and make public the rates they actually charge . . .," and "that the agricultural products' exemption apply only to the motor carriage of agricultural products and fish from producing areas to primary markets."

It behooves the fisheries and other agricultural trades to be alert and protect their position in order that the committee can give proper consideration to the effect of the impact of hostile legislation. Your dollars are involved in this matter. Exempt trucks hauling shipments to distant markets are economically shackled when they must return to the origin point empty. With prospects of international emergencies facing us, such rustling seems fallacious and wholly inconsistent. In effect, the I.C.C. in its MC-43 decision, now held in abeyance because of court action, in prescribing the arbitrary 30-day lease period is, as indicated, intended to eliminate trip-leasing. As an example, a truck hauling commodities such as seafood, from Florida to New York, could make a much lower charge north-bound provided it had the legal right of hauling a pay load southbound. At present there are no operative prohibitions because of pending court actions against the services of trucks and drivers being leased for the trip. The 30-day restriction would likely kill off completely, or at least reduce materially, the trip-leasing of trucks. The exempt trucker, knowing he must return with truck empty, would have to charge higher rates to take care of expenses for the two-way trip—one loaded and the other empty. The lamentable effect would be the complete exclusion of exempt commodities. With trip-leasing prohibited, it would mean practically no exemptions.

The Association of American Railroads in its release entitled, "Transportation in America" with reference to motor trucks said:

> "Motor vehicles carrying for compensation, property consisting of ordinary livestock, fish or agricultural commodities, which are now exempted from regulation by the Interstate Commerce Act and various State regulatory acts, should be regulated in the same manner and to the same extent as other operations for compensation."

It also made a statement in 1947 reading as follows:

> "The primary reason for railway entrance into the field of highway freight transport was to provide better service for patrons through utilization of certain advantages offered by highway operations. The principal aims were to speed up the movement of less-than-carload freight and to effect economies by the substitution of truck service for local freight-train service . . ."

To speed up the movement of less-than-carload freight and to effect econom-

es is exactly what the fisherman wishes to accomplish. Indeed, this he must do to stay in business. "What is good for the goose is good for the fish."

The railroads often refer enviously to the selectivity of tonnage handled by motor carriers. Unwittingly, the railroads themselves are becoming selective. In this age of progressive increases in per capita consumption, because of our higher standard of living plus the daily growth of our population, railroads are reaping the adverse reward of higher and higher freight rates and this is evidenced by the loss of approximately 2½ million carloads of freight, as compared with this time last year. Increased tonnage is being hauled, but not by the railroads.

What has been said points to the desirability of shippers of exempt commodities keeping this ultra important channel of distribution open at all costs in order to protect their distribution necessities. This is true because, generally speaking, neither the motor common carriers, the Express Agency, nor the railroads are enthusiastic about hauling fishery products. This is further evidenced by the high freight and protective service rates assessed. What are left, for the most part, are the private or exempt truckers who are willing to distribute fish tonnage. Increased rail transportation charges have caused shippers generally to look with more favor upon truck transportation because of 12 horizontal rail freight increases since June 30, 1946. When one mode of transport increases its rates the others generally follow. The availablity of exempt trucks acts as a balance wheel to keep transportation charges on a stable and rational basis.

To increase volume and reach out to new markets, equitable transportation charges, coupled with the assurance of the ultimate in speed and safety are of prime and continuing importance to your industry. To transport commodities efficiently and cheaply assures economic progress. High freight rates have never promoted domestic or international trade. The flexible distribution of goods is worth considerable to the economy of this country.

It is sometimes necessary for several fish distributors to pool-load or consolidate their shipments to make up a full truckload. Exemptions, therefore, are of value to both the large and small shippers of fish.

Deliveries of shellfish at Chicago, via motor truck were 20 percent of the total in 1946, and 51 percent in 1951. Fish product shipments during the same period from New England to Chicago, via motor carrier, increased from 5 percent to 94 percent. Fresh and frozen shrimp from the Gulf during 1946 amounted to 232 carloads via railroads, compared with only 11 carloads in 1951. Shrimp production increased 23 percent during the 1939-1950 period, not including imports from Mexico. These data indicate the huge diversion from rail freight and express to motor carriers—additional facts for preserving what you have by way of exemptions.

The combination of pending collateral matters—litigation and legislation principally—affecting the fisheries industry, if culminating unfavorably, could well create as a final result either the increase in transportation charges or a curtailment of service and the narrowing of marketing areas for the fisheries industry.

Being compelled to use the services of motor common carriers, even when they are permitted to move your kind of freight, will result in much higher transportation assessments. Common carrier truckers for the most part do not

desire to haul fish or shellfish. With incessant express rate advances, the necessity for guarding your present exemption rights under existing statute is definitely imperative.

Marketers of fish and shellfish, therefore, should adopt a persistent, concerted and dynamic program of action to preserve whatever constructive transportation arrangement is available to them and seek every possible improvement that will expand tonnage operations. Volume cannot expand with prohibitive transportation charges or with the narrowing of distributive limits which would obviously follow any curtailment of present exemptions.

From a practical standpoint and in the final analysis, the fisheries industry is concerned only with getting its products to market safely and in merchantable condition for sale at a price the consumer can afford to pay and one that will leave a balance sufficient for the fisherman to stay in business. Fish must be transported; they cannot swim to market.

SHELLFISHERIES SESSION

THURSDAY—NOVEMBER 20

Chairman—William W. Anderson, Fish & Wildlife Service, Brunswick, Ga.

Bacteriological Standards for Oysters Grown in a Semi-Tropical Climate

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A number of careful epidemiological studies have established that oysters which have become contaminated by intestinal or urinary discharges present a danger from typhoid fever and other enteric diseases to the consumers of these raw oysters. Since the Wesleyan University epidemic, investigated in 1894, definitely proved the possibility of a widespread outbreak of typhoid fever resulting from the eating of polluted oysters, a good deal of thought has been given to the problem of shellfish sanitation. The well-known epidemic typhoid fever that occurred during the winter of 1924-1925 affecting oyster eaters in major eastern cities was studied. While it cannot be determined exactly how many of the 1500 cases and 150 deaths from typhoid fever were caused by eating infected oysters, the data presented show that practically all these cases may have been caused by the consumption of polluted oysters.

For fifteen years the Florida State Board of Health has carried on an inspection program with the oyster industry, and during this time no outbreaks of enteric disease caused by eating oysters have been reported from any of the oyster houses under the State inspection program. In the winter of 1949-50 a shellfish laboratory was established by the Florida State Board of Health in Apalachicola, seat of the major oyster-producing area in the State. In 1951 the laboratory became a joint State Board of Health and Franklin County project. The purpose of the laboratory has been to protect the public through laboratory control activities with oysters and oyster growing waters. Approximately 100 stations have been established in Apalachicola Bay for the purpose of obtaining water samples of the oyster-growing areas to determine whether the area is safe for the growing of commercial oysters. Sporadic sampling was done in the Bay between the years 1937 and 1947, at which time a major bacteriological survey was made of Apalachicola Bay and the estuary of Apalachicola River, which flows into the Bay. Due to the shallowness of the Bay there is little stratification of water in the oyster-growing areas, eliminating the possibility that samples showed varying bacteriological populations are due to stratification of the water. This extreme shallowness of Apalachicola Bay is one of its outstanding features. The average depth of water is approximately five feet. There are many shallow flats, which at low tide have only inches of water covering them. Salinity within the Bay varies considerably. Ingle and Dawson (1950) pointed out that annual variations in salinity from fresh water to 42.5 parts per thousand of salinity were noted in the Bay and that tidal variations of 8.1 parts per thousand are not uncommon. These salinity conditions are

tolerated by the oysters, and commercial production is in operation where these conditions exist.

Studies indicate a rapid growth in the oysters of the Bay. The size of an inch may be achieved in five weeks and 2.6 inches of growth has been in 16 weeks. These growth rates suggest a high metabolic activity of the oysters, which may pump as much as 100 gallons per day through their gills. This may account for the high numbers of bacteria found in the bodies of the oysters.

In an attempt to aid the oyster industry to improve the quality of their product, samples of the oysters processed and sold by the industry were bacteriologically tested in the laboratory between September 1951 and May 1952. Laboratory procedures followed the routines as set forth in "Recommended Methods of Procedure for Bacteriological Examination of Shellfish and Shellfish Waters", published by the American Public Health Association (1943) except that a Waring Blender was used to marinate the oyster meats, instead of the use of glass beads.

Samples were taken from shucking houses. Shellstock was placed in clean paper bags, which were iced until delivered to the laboratory. Samples of shucked oysters were also obtained. These were shucked into sterile 150 ml ground glass-stoppered bottles. A third sample was obtained by choosing a random can of refrigerated shucked oysters from the oyster house cooler. Approximately 50 ml of shucked oysters were removed with sterile forceps, from the top of the can, another 50 ml were obtained from the center of the can after pouring the top half of oysters onto a skimmer, and a third 50 ml portion was taken from the bottom of the can after pouring the remaining oysters out of the can onto the skimmer. Laboratory results were recorded as 'Most Probable Number" of coliform organisms per 100 ml of sample. Total counts were determined by plating on Tryptone Glucose Extract Agar, and recorded as counts per ml of sample. Table 1 shows the bacteriological findings of the samples collected in the oyster houses. There is no correlation between shellstock results, shuckers results and random can sample results. No correlation can be found between any combination of these three sampling points. The correlation coefficient for the series of Most Probable Numbers is as follows: Shellstock and shuckers 0.65, shellstock and random can samples 0.0483, shuckers and random can samples 0.620.

All of the results in Table 1 represent production from one oyster house, and many of the samples included in the table are those from oysters from one particular bar in Apalachicola Bay. The presence of high densities of coliform organisms in the oysters showed no pattern or correlation with external factors such as air temperature, water temperature, tidal action or coliform organism densities.

Since all of these oyster samples were taken from a certified shucking house, all of the oysters represented in Table 1 are from waters which have been declared safe for the commercial production of oysters and which therefore show a median Most Probable Number (MPN) of coliform organisms per 100 ml of sample of well below 70.

Parallel samples on the chart are those taken at the same time in the oyster house. Table 2 shows results that are typical of the work done in connection with oyster sanitation in Apalachicola Bay. The results indicate quite clearly that this is no close correlation between corresponding Most Probable Num-

TABLE 1

BACTERIOLOGICAL RESULTS OF SAMPLES TAKEN FROM SHUCKING HOUSES EXPRESSED AS MPN (MOST PROBABLE NUMBER OF COLIFORM ORGANISMS PER 100 M.L. OF SAMPLE AND TC (TOTAL BACTERIAL COUNT))

SHELLSTOCK		SHUCKERS		RANDOM CAN	
MPN	TC	MPN	TC	MPN	TC
		3,500	8,000		
		1,700	4,000		
16,000	>3,000				
1.8					
45	>3,000				
340	>3,000				
330					
490					
790					
1,100					
1,700					
1,300					
1,700	3,000				
3,500	5,700				
1,100	>300				
790	>300				
330					
330					
490					
1,300					
		11,000	20,000	5,400	5,000
		1,700	70,000	160,000	<300,000
790		1,100		2,400	
110	>3,000	3,500	12,000	16,000+	20,000
		490	30,000		
				3,300	800
				1,700	12,000
1,300	>300				
9,200					
		230	50,000		
		49	30,000		
		330	63,000	3,500	NO
		9,200	<300,000		
		1,300	3,500	1,100	5,000
		2,400	4,500		
33	>3,000	3,500	27,000	3,500	22,000
		11,000	900	3,500	ND
1,400	>3,000				
		700	>7,000		
3,500	>3,000	2,400	>3,000	3,500	>3,000
		11,000	16,000	17,000	7,000
		950		16,000	
		110	ND	4,600	<30,000
		13,000			
1,700	>3,000	220	>3,000	130	1,200
				330	
				700	
		5,400	9,000	5,400	60,000

SHELLSTOCK		SHUCKERS		RANDOM CAN	
MPN	TC	MPN	TC	MPN	TC
				3,500	300,000
				9,200	<300,000
				16,000	<300,000
				210	36,000
		13	>3,000	68	4,000
460	>3,000	490	5,000		
2,300					
		350	3,000	310	5,000
		16,000	12,000	16,000	20,000
9,200	10,000				
		170	4,000	700	5,000
480	5,000	3,500	12,000	5,400	ND
		950	3,100	170	13,000
78	>3,000	230	5,000		
				17,000	<3,000
		490	3,600		
490				1,300	
		16,000	80,000	1,700	140,000
				1,300	270,000
				9,200	22,000
		78	50,000	2,200	280,000
		16,000	10,000	16,000	20,000
5,400	>3,000				
		1,700	10,000	1,700	7,000
490	>3,000	2,400	>3,000	4,300	ND
		6,400	20,000	54,000	9,000
				7,000	>30,000
		13,000		9,200	
		16,000	20,000	16,000	8,000
		2,400			
		92	>3,000		
260	3,000	3,500	15,000	790	ND
		78	3,500	68	>3,000
140	>3,000	340	20,000	790	30,000
				5,400	3,000
				1,700	20,000
790		790		2,200	
		2,400	7,000	1,300	7,200
		1,300	20,000		
1,700	5,000	330	12,000	9,200	
		9,200	20,000		
		3,500	ND	3,500	ND
2,200	>3,000				
		330	4,300	3,500	3,600
1,300	ND	490	4,000	490	3,000
				2,400	7,000
16,000+	20,000	3,500	10,000	3,500	10,000
		16,000	24,000		
				1,400	6,000
		16,000	<30,000	16,000	30,000
		16,000+	25,000	16,000	30,000
		7,000	ND		
		4,900	5,000	9,200	3,500

SHELLSTOCK		SHUCKERS		RANDOM CAN	
MPN	TC	MPN	TC	MPN	TC
2,200	3,000	1,700	3,000	3,500	6,000
		1,800	2,000	3,500	3,000
		5,400		16,000	
790	>3,000	9,200	20,000		
5,400	>3,000				
16,000+	24,000	16,000+	ND		
4,100	>3,000				
790	>3,000	2,800	>3,000	5,400	>3,000
				11,000	9,000
				3,500	ND
		16,000		490	
				1,300	1,000
		2,400	8,000	16,000	10,000
				790	15,000
		490	>3,000	1,300	7,500
400	>3,000	790	3,200	3,500	16,000
		1,700		2,200	
9,200	10,000	16,000+	20,000	16,000	10,000
		3,500		1,300	
3,500		16,000+	28,000	16,000	12,000
16,000	8,000	9,200	20,000	16,000	
5,400	10,000	9,200	28,000	9,200	16,000
2,400	3,500	9,200	20,000	2,200	8,000
2,400		9,200	10,000	9,200	
490	3,000	1,700	4,000	1,400	4,000
170	3,000	460	3,000	490	4,000
330	3,000	2,400	5,000	1,300	8,000
1,800	3,000	790	3,000	460	3,000
330	3,000	330	4,000	490	9,000
16,000	32,000	16,000	30,000	16,000	30,000
16,000	30,000	5,400	30,000	16,000	30,000
MAXIMUM					
16,000	32,000	16,000	300,000	160,000	300,000
MEAN					
3,244	5,700	5,052	19,351	8,244	40,590
MEDIAN					
1,200	3,000	2,400	10,000	3,500	11,000
MINIMUM					
1.8—	300	13	900	68	800

er of coliform organisms and Total Count. The correlation coefficient between the Most Probable Number and Total Count is 0.035.

Table 3 shows the Most Probable Number frequency of occurrence in the mples taken from the shucking houses. As can be noted, between 5 per cent nd 10 per cent of the samples had an MPN of less than 230. Between 41 per nt and 60 per cent showed an MPN less than 2,300, and between 40 per nt and 60 per cent showed an MPN higher than 2,300. Whatever the

point of sampling and whether or not the oysters were shucked from the shell aseptically in the laboratory or in the oyster shucking house, these percentages are representative.

TABLE 2

Corresponding MPN and Total Count of Samples Taken from Shucking Houses

MPN	Total Count—Expressed as Thousands															
100		1		8							1					1
200		1	1	3										1		
300			1	1	1						2					1
400			3	3	2							1				
500			4	6	3											
600																
700					(1)			1			1	1				
800	1		1	3												
900																
1,000				1						1	3					3
2,000	(3)	1	(4)	(5)	2	1	1	3								1
3,000			3	2	2		(3)	(3)		1	(4)	2				(1)
4,000	1		1	3		(2)		1		1		2				
5,000				1	2				1	1						1
6,000			1	2								1				1
7,000											1		1			
8,000																
9,000			1							1	3	1				1
10,000										(2)	2	1				1
15,000	1								(1)		2					
20,000			1	1						3	8	(12)	1			2
20,000									1							1

It can be noted from Table 3 that MPN values above 2300 occur in greater frequency when there was more handling of the oysters. Conversely, MPN frequencies less than 2300 seem to decrease with handlings of oyster meats.

In an effort to determine the relationship to the Most Probable Number of coliform organisms found in oysters and water were run in the laboratory. The results of these samples are shown in Table 4. Unfortunately, procedures of sampling the water on an oyster bed at the same terms that oyster samples are being taken from the bed had not progressed to a degree where ample results are available for statistical analysis. The correlation coefficient between the water MPN and oyster MPN is 0.0110. From such samples there is no apparent correlation. No fixed ratio is evident so that it would be possible to compute the MPN of an oyster sample from its corresponding water score. Perhaps the oyster reflects past quality of its growing water and further study may reveal the time element relationship between water and oyster MPN's.

TABLE 3

OYSTER

MOST PROBABLE NUMBER FREQUENCY OCCURRENCE

MPN Less Than	Shellstock	Shuckers	RC
100	4	4	2
230	3	5	3
300	1		
400	6	6	2
500	8	7	5
600			
700		1	1
800	6	2	5
900			
1,000		2	
2,000	14	10	14
3,000	7	8	7
4,000	3	9	13
5,000	1	1	2
6,000	4	3	7
7,000		2	
8,000			1
9,000			
10,000	6	11	7
15,000		4	1
20,000	17	16	23
25,000			
30,000			
40,000			
50,000			
50,000+			
Total Samples	80	91	95

TABLE 4

OYSTER SAMPLES AND CORRESPONDING WATER

	DEPTH SAMPLE		MOST PROBABLE NUMBE	
	Water (In.)	Oyster (Ft.)	Water	Oyster
Cat Pt.	6	2	17	78
"	6	6	2	130
"	6	3	7.8	40
"	6	3	4.5	37
"	6	2	1.8	78
11 Mi. Flat	6	unknown	2	490
Paradise	6	"	1.8—	130
"	"	"	11	110
E. Bay	6	4	49	17,000
"	6	4	70	35,000
"	6	4	33	9,500
"	6	3½	7.8	3,500
"	6	3½	2	3,300
"	6	3½	1.8	28,000
"	6	4	17	4,600
"	6	4	33	24,000
"	6	3½	2	7,000
"	6	7	170	1,300
"	6	7	540	3,500
"	6	7	4.5	490
"	6	4	2	3,500
"	6	3½	2	2,400
"	6	4	1.8—	9,200
"	6	4	1.8—	790
"	6	3	1.8—	790
"	6	6	1.8—	130
"	6	4	1.8—	220
"	6	8	110	45
"	6	5	79	1,700
"	6	6	79	1,700
"	6	4	240	330

Summary

1. Comparison of the Most Probable Number of coliform organisms and total bacterial count of oysters taken from the oyster houses reveals that the number of bacteria tends to increase with each successive handling of the oysters in the shucking house.

2. There appears to be no correlation between the Most Probable Number of coliform organisms with the total bacterial count of samples taken in the oyster houses.

3. The recommended scores listed by the Federal Security Agency, United States Public Health Service, should be reviewed relative to application to oysters from semi-tropical waters such as the Gulf of Mexico.

4. Studies should be made to determine the effects of salinity in brackish water on the death rate of coliform organisms.

5. Studies should be made to determine the effects of salinity in brackish water on the death rate of coliform organisms.

6. Studies should be made to determine the effects of temperature on the bacterial population of oyster-growing waters and oysters from these waters.

7. Studies should be made to determine the effects of temperature on the death rates of coliform organisms in oyster-growing waters.

8. Studies and investigations should be made relative to setting standards by which the sanitary quality of oysters may be judged.

9. Studies should be made to determine the relationships between bacterial counts obtained when a Waring Blendor is used and those obtained as outlined in Standard Methods where glass beads are used.

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Importance of Local Environment in Oyster Growth

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Cultivation of the oyster, *Crassostrea virginica*, Gmelin, has always been dependent to some degree on the transplanting of young oysters from so-called seed areas to growing grounds. In recent decades, however, the planter has had to go progressively farther afield for his source of seed and the scarcity of seed oysters in many producing areas is a problem of increasing concern. The transportation costs involved in these operations make it imperative that the imported stock survive and grow at better than average rates. Oysters are readily transplanted many thousands of miles from the area in which they set, but stocks from some areas have been found to grow better than others. It has been shown too, as in the case of the eastern oyster transplanted to the Pacific coast, that oysters, while growing well in a new environment may fail to reproduce normally. For these and other reasons, it has become desirable, if not imperative, that the biologist study growth and mortality rates in as many different imported stocks as possible so that the best of these may be recommended to the commercial planter.

Stocks of oysters from the Pensacola area, where there is an abundant set, have been sent to several different geographical regions to develop information on this problem. In cooperation with Mr. Francis Beaven of the Chesapeake Biological Laboratory at Solomons Island, Maryland, reciprocal plantings of native oysters have been made. This paper summarizes observations on Chesa-

peake Bay oysters in Florida and compares their growth with that of Florida native stock.*

The Pensacola laboratory received a supply of Chesapeake oysters in December, 1950, when they were about six months old. The edges of the oysters were broken smooth in shipment, and there was an initial mortality of 10 per cent. The oysters were separated from the natural cultch, cleaned and placed in wire trays having fifty individual compartments. Identical trays containing Pensacola spat of the same approximate age were prepared and duplicate sets of trays were placed at each of two locations, designated as East and West stations. The trays hung three feet below mean low water and were about four feet above a barren sand bottom. Length, dorso-ventral width and the weight of each oyster were recorded at regular intervals for the next 18 months, i.e., until the oysters were two years old. Water temperature and salinity levels were recorded continuously at the West station, intermittently at the East station.

During the 18 months of observation there was a total mortality in all trays of 51 per cent. The drill, *Thais*, caused 32 per cent of this mortality, the remainder (19 per cent) was due to unknown agents. This amount of mortality, 19 per cent, is expected under our experimental conditions at Pensacola, over a period of 18 months. The mortality rates in the Chesapeake group were the same as in the local oysters although more of the local oysters

* I am indebted to John R. Wiggins and John S. MacGregor, former Fishery Aids at this laboratory, for some of the measurements reported here.

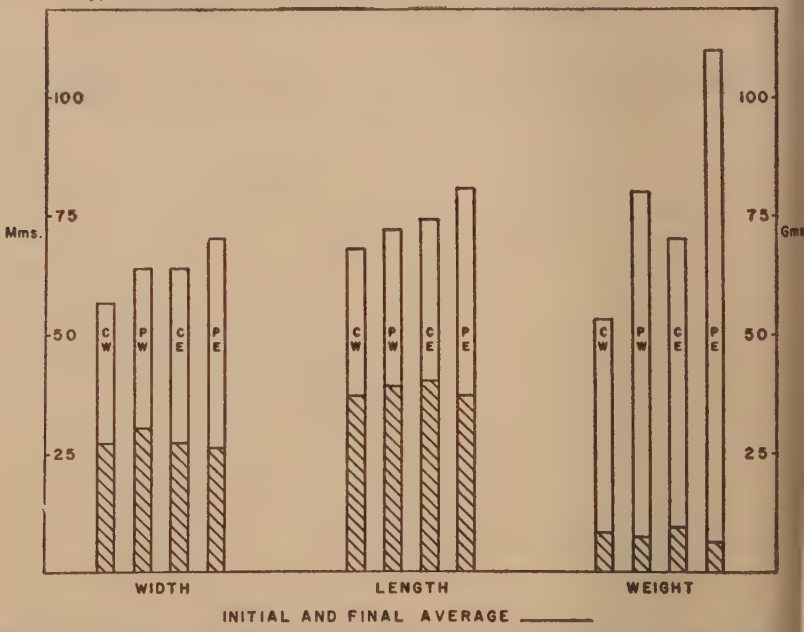

FIGURE 1. Average measurements of four groups of oysters at Pensacola, Florida in January 1951and July 1952. Chesapeake and Pensacola oysters grown at West stations are indicated by CW and PW; the same stocks grown at East station are indicated by CE and PE respectively.

were lost because of drill damage in one tray which fell to the bottom. There was no consistent difference in mortality rates at the two stations or during particular seasons of the year.

During the first few months of observation the Chesapeake oysters grew especially well, and faster than the local controls. This was perhaps due to the stimulus of being moved to a new environment. This rapid growth was, of course, at a time when the oysters would have been hibernating had they remained in their original environment. At the close of the experiment, some oysters in both stocks were over three and one-half inches long but there were also many only two and one-half inches long. All oysters were well shaped, with smooth rounded shells, as a result of the routine cleanings they received. All were infested to some extent with boring sponge and it is probable that some contained the boring clam, *Martesia*. At least 15 per cent of the Chesapeake oysters were sponge infested on arrival and presumably this condition had no material effect on the final results.

TABLE 1

CHESAPEAKE AND PENSACOLA OYSTERS AT PENSACOLA, FLORIDA, 1951-1952

	Jan.	Mar.	May	July	Sept.	Nov.	Jan.	Mar.	May	July
Chesapeake-										
Length, mms.	40	46	52	55	58	60	66	72	74	74
Width, mms.	27	35	42	43	43	45	52	61	65	64
Weight, gms.	9	12	19	28	33	40	48	58	66	70
	10	19	42	66	82	108	165	255	318	332
Mortality				4	2		4			6
Chesapeake-										
Length, mms.	37	42	47	49	52	54	59	65	67	68
Width, mms.	27	34	38	38	39	40	47	54	58	57
Weight, gms.	8	10	16	22	26	31	37	45	51	53
	8	14	29	41	53	67	103	158	198	205
Mortality			2	2			10	4		2
Pensacola-										
Length, mms.	37	43	49	55	62	66	71	78	81	81
Width, mms.	26	32	40	43	46	48	56	67	71	70
Weight, gms.	6	8	15	28	43	55	69	86	99	110
	6	11	29	66	123	174	274	449	569	624
Mortality		2		4	6		6		8	4
Pensacola-										
Length, mms.	39	44	48	51	53	56	62	67	71	72
Width, mms.	30	36	39	41	42	43	51	60	65	64
Weight, gms.	7	10	20	27	33	39	50	62	70	80
	8	16	37	57	74	94	158	249	323	369
Mortality		2	2							2

Average data recorded on first day of month for four groups of oysters at two stations.

The oysters showed great individual variability in the amount and timing of growth increases, as is to be expected, but the distribution of size frequencies was normal both initially and at the close of the experiment. On a commercial basis, the performance of the entire population is of more interest than that of the extreme individual. For this reason the data are presented as that of group averages and all measurements are rounded to the nearest whole number. Data are based only on oysters surviving beyond the end of the experimental period. Of the 400 original oysters, 16 were damaged or lost, 112 killed by drills, 86 died and 188 survived. Table 1 is a summary of the pertinent data.

Figure 1 illustrates the average size of the four groups of oysters at the start and close of the experimental period. Pensacola oysters at the east and west stations are designated PE and PW, Chesapeake oysters as CE and CW respectively. Initial differences in the average measurements of the four groups were quite small and are without significance. After 18 months the four groups were clearly differentiated in size and especially in regard to weight. PE oysters were consistently the longest, widest and heaviest. The CW group was the smallest in these respects, while CE and PW occupied intermediate positions.

These data on length, width and weight may be combined arbitrarily into a single factor representing growth in the several dimensions simultaneously.

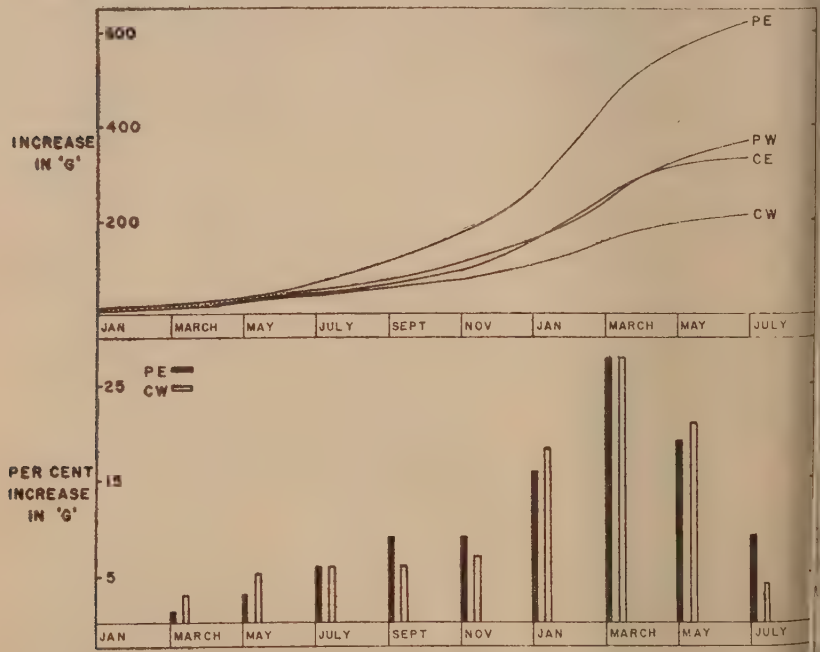

FIGURE 2. Bimonthly increases in calculated 'G' factor in four groups of oysters, where 'G' is product of length, width and weight divided by 1000. Percentage increase in 'G' when total 'G' for 18 months is considered to be 100. Pensacola East oysters, PE, attained largest average size; Chesapeake West oysters, CW, attained smallest average size.

This factor, which is termed 'G', is the product of length, width and weight, divided, for convenience, by 1000. In this study, the 'G' factor ranged from six in the young oysters to over 600 in the PE group, at 18 months. In Figure 2, the upper graph shows increases at bi-monthly intervals of the calculated 'G' factor for the four groups of oysters. These curves indicate clearly the distinctive nature of the growth increases in the different trays of oysters. During the first six months there were no sharp differences in average data, although the pattern of growth was clearly established. From this time until the end of the following year differences between the groups became accentuated. The uniformity of the several growth patterns was such that monthly gains in any three groups could have been predicted by the performance of the fourth group. This uniformity indicates that the factors controlling growth in the different groups were permanent features of the internal or external environment and not seasonal in nature.

These data may be presented in another way, to consider the total 'G' for the 18 months to be 100 and then indicate the per cent increases in 'G' at regular intervals. Such data are shown in the lower graph of Figure 2 for the fastest and slowest growing groups, PE and CW. It is important to note here that percentage increases in these groups are very similar, sometimes identical, at each time interval throughout the experimental period. Data for groups PW and CE, although not shown, possess the same pattern. Up until the last observation, increases in any one period for all four groups of oysters do not vary by more than four per cent of the total. It is justified to conclude then, without regard to actual growth in grams and millimeters, that all four groups grew at nearly identical rates in terms of their capacity to grow. This implies, further, that the rate of metabolic activity in each group was influenced to a similar degree by the environment. This is an expected conclusion, considering that temperature levels paralleled each other at the two stations. It is believed that this means that temperature, and probably salinity also, can be eliminated as decisive factors in producing the different growth patterns.

Despite similarities in rates of growth, the four groups of oysters attained quite different final sizes. This may be shown most clearly by tabulating the final 'G' factor for each group:

PE — 624	CE — 332
PW — 369	CW — 205

If the group with the lowest rating is reduced to unity, relative growth may be represented approximately as follows:

PE — 3X	CE — 1.5X
PW — 1.5X	CW — X

The data on any one of the measurements, such as length, width or weight could be treated in the same manner, but when this is done the distinctions between the four groups become less obvious.

This tabulation makes certain relationships apparent. Oysters at the East station did at least half as well again as the same stocks at the West station; the Pensacola oysters at each station grew at least half again as well as the Chesapeake oysters. The PW and CE oysters grew approximately as well as each other; the PE oysters grew three times as well as the CW group.

It must be concluded from these facts that not only is the environment at the two stations fundamentally different, but also, that local oysters grow far better than Chesapeake oysters in this area.

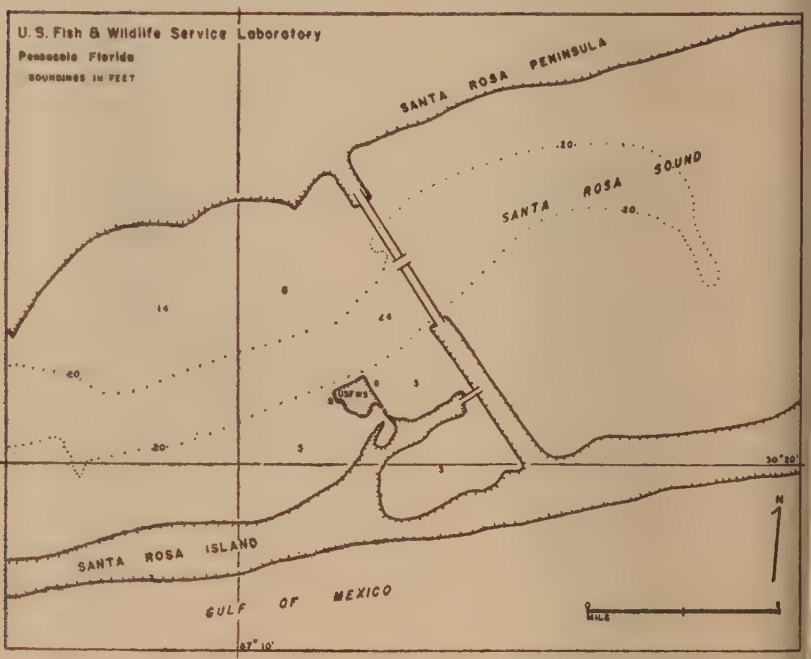

FIGURE 3. Location of laboratory island, USFWS, near Pensacola Florida. East and West stations are located at 6 and 9 foot soundings shown on either side of laboratory island and are 1000 feet apart.

The location of the two stations should assist us in interpreting these results but instead presents an additional problem. The diagram in Figure 3 shows the locations of the stations at the 6 and 9 foot sounding on either side of the laboratory island. The stations are not more than 1000 feet apart; they are exposed apparently to the same water currents; temperature and salinity levels parrallel each other. So far as can be determined without extensive chemical analyses, the two stations are similar, except that at one the morning sun is dominant and at the other the afternoon sun. Nevertheless, differences between samples of the same stock of local oysters placed at the two stations were greater in some instances than the differences between local oysters and oysters transplanted here from Chesapeake Bay, over 700 miles away.

It is fortunate that these plantings were made reciprocally at the two stations. Suppose that an investigator had made test plantings of a similar nature, but not using as many samples. Since a thousand feet between plantings is not ordinarily considered of importance, any one of the following combinations of plantings might have been made:

a. PE and CW
b. PE and CE
c. PW and CE

In these three selected combinations, the following conclusions would have been inevitable:

a. Pensacola oysters grow three times as well as Chesapeake oysters,
b. Pensacola oysters grow twice as well as Chesapeake oysters, or
c. Pensacola oysters and Chesapeake oysters grow equally well.

Unfortunately, such anomalous conclusions are much more than a theoretical possibility in an incompletely controlled test planting.

It would be desirable to go on from this point and describe the environmental factors which differentiate the east and west stations, but the data necessary to interpret this situation are not available. Of greater importance is the fact that it is not certain what data are necessary to interpret this situation. Until the superiority of one location a thousand feet from another can be accounted for it is not possible to interpret or predict the results of moving oysters up and down the coast—except on a trial and error basis.

From the little data available, there appears to be no logical explanation for the different results obtained at these two stations. The apparent continuity of water currents between the two areas would seem to preclude the existence of local concentrations of some water-borne factor. The absence of natural populations of oysters, or concentrations of other sedentary organisms, eliminates from consideration the possible effects of population densities. These conditions, combined with the similarity in the physical arrangement of the test oysters at the two stations, leaves little basis for profitable speculation on what factors are involved.

When the reasons for the poor growth of the Chesapeake oysters as compared to the local stock at the same station are examined it is equally difficult to arrive at any satisfactory conclusions. Mr. Beaven states that Pensacola oysters transplanted to Chesapeake Bay grow at slower rates than the native oysters. Thus it appears that each of these stocks of oysters does best in its own environment. This is certainly not due to an inherent adaptation to a warmer or colder climate. The slow growth pattern of the Chesapeake oysters was well established here before the water became any warmer than it is customarily in Chesapeake Bay. Nor can it be assumed that these oysters in the six months prior to transplanting became so accustomed to the local food supply that they were unable to adjust completely to the food in the new environment. The seasonal variation in the variety of plankters at either one location is probably as great as the differences in the plankton between Chesapeake Bay and Pensacola. There are numerous instances of transplants growing much better when their environment had been changed radically. No explanation is offered at this time for the observed differences in these groups of oysters.

It seems desirable that biologists make special efforts to examine in all possible detail the factors which interact to make a particular environment more or less suitable for oysters. A concerted attack on this problem may be far more productive than the wide-ranging surveys of oyster producing areas which have occupied so much of the investigators' time in the past. It is hoped that considerable effort can be devoted to a comprehensive study of

the situation described here. The stations are convenient to the laboratory, and the fact that the essential differences must not be seasonal or sporadic, but exist throughout the year, makes this situation especially promising for an intensive investigation.

Studies on the Effect of Dredging Operations upon Fish and Shellfish*

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ABSTRACT

Investigations were made to determine the effects of dredging operations upon fish and shellfish in the vicinity of Great Point Clear, Alabama. Damage to scalefish and motile crustacea was not observed, even within 25-50 yards of an active dredge. Shellfish were not found to suffer damage when suspended from dredge itself. Damage due to larger particles of mud occured on bottom in immediate neighborhood of dredge, but did not extend beyond 400 yards. In most cases this distance was much less, in some cases being about 75 yards.

Because momentary conditions of tide, speed of current, speed of dredging vary, and variations exist in various bay bottoms, every situation merits separate consideration. *Controlled dredging* is suggested as the best solution. By this method the dredging activity is coordinated with local conditions, spatial and temporal. In the areas under consideration (West Florida and Alabama), controlled dredging should begin to operate at 400 yards distance from live oyster reefs.

The results of this study, carried out in deeper water, parallel those obtained by Lunz in his excellent studies in the St. John's River, Florida, and the Santee River area of South Carolina. The present study and those of Lunz underline the fact that damage to fishery animals due to dredging is frequently overrated.

There is some evidence that dredging stirs up organic detritus resulting in a beneficial effect to shellfish and crustaceans.

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Studies on the Vertical Distribution of Setting of Oysters in North Carolina

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In many oyster producing areas of the southeastern states of the Atlantic coast, concentrations of oysters grow in the intertidal zone, frequently with no adult oysters found below the low water level. The influence of water currents and a differential mortality rate caused by fouling organisms have been offered as a partial explanation for the vertical distribution of adult oysters. This has led to studies of the vertical distribution of setting in some localities. The possible significance of such studies has been pointed out by Galtsoff (1930) who wrote, "the knowledge of the exact location of the setting zone is as important to the oyster culturist as is the knowledge of the time of setting".

In a review of the studies on the vertical distribution of setting of the eastern yster (*Crassostrea virginica*) there are considerable variations in the location f the zone of heaviest setting. Galtsoff and Prytherch (1927) reported that he peculiar distribution of oyster beds in South Carolina, Georgia and North Carolina is due to the setting of oysters between tide levels and postulated that he current is probably the prime factor controlling the distribution of the atural beds. This was followed by experiments in other areas. At Milford Harbor, Connecticut, Prytherch (1929) found that oysters set at all levels rom the bottom of the channel to two feet above low water level with the eaviest setting near the bottom, but in Great South Bay, Long Island, setting ccurred from the bottom to the approximate high water mark. Later Prytherch 1934) correlated setting with current velocity and copper content to explain he vertical distribution of setting in Milford Harbor. Loosanoff and Engle 1940) confirmed the findings of Prytherch that the zone of heaviest setting n Milford Harbor was on the bottom.

Galtsoff and Luce (1930) studied the vertical distribution of setting in Georgia by stacking pairs of shell bags. They found the zone of heaviest setting o be above the low water level. Studies in Massachusetts by Galtsoff (1930) howed that the zone of heaviest setting in Wareham River was above the low ater level. At Onset, Massachusetts, he found that setting occurred from the ottom of the channel to two feet above low water level, with no setting at the igh water mark. The maximum set was from one and one-half feet to two eet above low water. Needler (1931) found the heaviest setting in Bideford River, Malpeque Bay, to occur from two to three feet below the low water level. These studies by Galtsoff in Massachusetts and Needler in Canada were made y placing bags of shells on the bottom, beginning at the high water mark, hrough the low water level to the channel and are not actual vertical distribu- ion studies as made by other investigators.

Loosanoff (1932) studied the vertical distribution of setting in three local- ies in Virginia using a cement coated pole as cultch. In the James and Corro- oman rivers the zone of heaviest setting was found near the bottom. At Wach- preague, Virginia the heaviest setting was from one and one-half feet to three eet above the low water level. Mackin (1946) repeated the studies at Wach- preague and found the heaviest setting from the low water level to two feet bove low water.

MacDougall (1943) in studying the attachment of sessile marine inverte- rates at Beaufort, North Carolina, found the heaviest set of oysters to occur ear the bottom. Recent studies in South Carolina reported by McNulty 1953) show that the maximum setting in three localities was from one foot elow low water to one foot above low water.

Studies of the vertical distribution of setting of other species of oysters have hown equally diversified results. Seki and Tanaka (1931) found the greatest umber of oyster spat of *Ostrea denselamellosa* near the bottom. McMillan nd Bonnet (1931) point out the advantages of suspended oyster culture in alifornia waters with *Crassostrea gigas*, writing that a maximum set is ob- ined on suspended tarred ropes. Ota (1948), cited by Cahn (1950), found Hiroshima and Kumamoto prefectures that the zone of heaviest setting in hallow water for *Crassostrea gigas* was at a depth of 40 to 100 cms above the ottom to the low low water level, but in deeper waters the zone of heaviest tting was from 0 to 100 cms above low low water level.

Bonnot (1936) writes that spat collectors for *Ostrea lurida* in California are laid on the bottom or suspended from logs or floats. Hopkins (1937) suspended baskets of shells at various levels from a float to study the vertical distribution of setting of *O. lurida* in Puget Sound and found that the heaviest setting takes place from 6 to 30 inches below the surface.

Cole and Knight-Jones (1939) found that the spat of *Ostrea edulis* were evenly distributed in intensity from the bottom to the surface on the inner surfaces of their tanks at Conway. Experimental shells placed in the tanks just below the surface, at mid-depth, and near the bottom showed the heaviest setting on the shells near the surface. Korringa (1940) clearly demonstrated in field experiments that the heaviest setting of *Ostrea edulis* in the Oosterschelde occurs near the bottom. Experiments by Cole and Knight-Jones (1949) of the vertical distribution of setting in the Helford River, Cornwall, confirmed the findings of Korringa, but they found conflicting results in the tanks at Conway.

In the studies of the vertical distribution of setting two of the investigators present some evidence of the mortalities that may take place. Mackin (1946) found that 75 to 83 percent of the spat at Wachapreague, Virginia, were killed by oyster drills between June and December. Test panels used in the studies by MacDougall (1943) were left overboard with attached oyster spat from August 15 to December 27. No oysters remained below low water level, and MacDougall concluded that the heavy growths of hydroids, sponges, tunicates and other encrusting organisms smothered the young oysters.

Studies on setting of oysters were started in North Carolina at the Institute of Fisheries Research in June, 1948. Spat collectors placed on the bottom at the Institute pier in Bogue Sound in depths of eighteen to twenty feet showed that heavy sets of oysters occur at the bottom in an area where adult oysters are found only in the intertidal zone. Some preliminary studies were made in 1951 to determine the vertical distribution of oyster setting using clam shells strung on a wire at foot intervals. Setting of oysters was found to occur at all levels. This was followed by studies in 1952 to determine the vertical distribution and intensity of setting at foot levels in five different areas (see Figure 1).

Description of areas:

The distribution of adult oysters at three of the stations, Cape Lookout, Pivers Island and Institute pier is generally limited to the intertidal zone. In Bay River and Core Creek oysters are found growing on the bottom and distributed vertically along piling and similiar structures.

The tidal fluctuation, except in Bay River where there are no periodic tides, is from two and one-half feet to four feet at the four stations. In Bay River the slight rise and fall of water level is governed by the prevailing winds. The depth of water at the various stations was eight feet at Pivers Island and in Bay River, thirteen feet in Core Creek, sixteen feet at Cape Lookout, and eighteen feet at the Institute pier.

Water temperatures at the five stations during the period the studies were made ranged from 24.0°C to 32.8°C. At the Institute pier, Pivers Island and Cape Lookout the salinities ranged from 30.0 parts per thousand to 36.3 p.p.t. The greatest fluctuation in salinity was at the Core Creek station where readings from 18.4 p.p.t. to 37.0 p.p.t. were recorded. The salinities in Bay River ranged from 14.2 p.p.t. to 18.4 p.p.t.

The station at Cape Lookout was located in the bight at the government ier. At Pivers Island the series of shells was suspended from the U.S. Fish and Wildlife Service dock. At Core Creek the studies were made from a small pier djacent to the north side of the highway bridge across the Intracoastal Waterway. In Bay River the shells were suspended from a group of piling on the outh shore of the river at Bell Point.

Methods:

Small wire baskets, eight inches square, were constructed of one inch hexgonal mesh wire. Clam (*Venus*) shells of uniform size, measuring approximately three and one-half by three inches in length and width were used as spat ollectors. Two pairs of shells were placed in each basket with each pair facing n opposite directions. The baskets were wired at foot intervals to a length of hain anchored with a cement block, and suspended from a pier. The shells ere changed at weekly intervals, and counts were made of the oyster spat ttached to the inner surfaces of the shells.

Results:

The results presented here are from studies made during the months of June, uly and August, 1952. Table 1 contains the average counts of spat per shell t each station for three weekly series of studies.

TABLE 1

VERTICAL DISTRIBUTION OF OYSTER SPAT AT FIVE LOCALITIES IN NORTH CAROLINA. FIGURES REPRESENT AVERAGE SPAT-PER-SHELL COUNTS FOR THREE WEEKS.

Depth	Cape Lookout	Institute Pier	Core Creek	Pivers Island	Bay River
3	0.4			0	
2	0.4	0	0	0	
1	3.	1	1	0.2	
LW	12.	10	1	4.	8
— 1	40.	10	2	12.	53
— 2	35.	10	3	13.	132
— 3	44.	7	2	22.	204
— 4	45.	14	4	52.	243
— 5	55.	16	4	128.	341
— 6	53.	20	4		280
— 7	74.	25	3		232
— 8	89.	27	5		
— 9	123.	24	4		
—10	244.	36	4		
—11	530.	24			
—12		34			
—13		42			
—14		34			
—15		33			

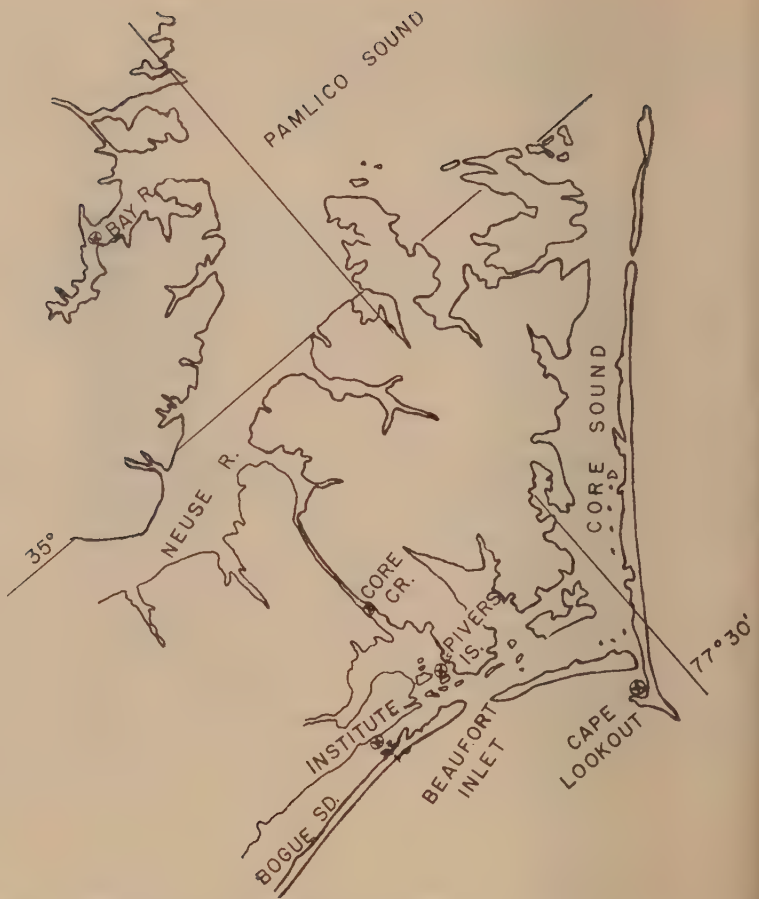

FIGURE 1. Map of portion of eastern North Carolina showing the location (★) of each station for vertical distribution studies.

From the data, a trend of increased setting intensity is noted nearer the bottom. This is particularly evident at the stations at Cape Lookout and Pivers Island. Both of these stations are located in sheltered areas away from the influence of strong currents. In Bay River, the currents are sluggish of negligible but the average count shows that the maximum setting occurred three feet above the bottom. During the three week interval when these data were collected in Bay River, the level of maximum set varied among the lower three series of shells. The heaviest set during the week of July 28 to August 4 was on the bottom series of shells with an average of 344 spat per shell, and in the following week the heaviest set was two feet above the bottom with an average set of 375 spat per shell.

At the Institute pier and Core Creek setting intensity was light in comparison to the other stations, but the trend of heavier setting near the bottom was

still evident. These series of shells, at the two stations, were exposed to the direct effects of the strong water currents that flow by the piers.

The intensity of setting above low water level was markedly reduced at those stations located in areas where the tidal fluctuations occur. No oysters were found attached to the shells placed at the high water level, but light sets of barnacles were frequently found on the shells.

TABLE 2
SETTING INTENSITY OF OYSTERS ON SHELLS EXPOSED FOR ONE MONTH, PIVERS ISLAND

Depth	Spat/Shell	Number Drilled
2	0	0
1	8	0
LW	24	0
—1	14	0
—2	17	0
—3	25	1
—4	41	15
—5	5	57

A series of shells was left overboard for one month (July-August) at Pivers Island to determine the rate of mortality. These results are presented in Table 2. After a month of exposure the shells were heavily encrusted with growths of bryozoa, hydroids, barnacles and tunicates. Many of the oysters had died, and those with both shells intact in many cases showed evidence of mortality caused by oyster drills. The heaviest set was on the shells two feet above the bottom, and a marked increase in the number of spat at the low water level was noted. The intensity of fouling organisms on the shells at low water level was not as great as on those shells below low water. The greatest mortality was on the shells near the bottom.

In the high salinity areas, at Cape Lookout, Pivers Island and the Institute pier, spat less than a week old were found killed by oyster drills. In one weekly series at the Institute pier 23 spat from a total of 516 spat were found drilled on the shells nearest the bottom. At the three stations in the high salinity areas, evidence of drill damage was seen in each weekly series. The greatest mortality was always on the spat attached to the shells nearest the bottom, but the shells which were two and three feet above the bottom also contained spat that had been killed by oyster drills.

Summary:

The studies presented were primarily designed to determine the vertical distribution of oyster setting at several stations with particular emphasis on the intensity of setting in those areas where concentrations of adult oysters are growing in the intertidal zone. It was found that the intensity of setting below low water level was far in excess of the set above low water. Some evidence was collected of the high rate of mortality below low water level which may offer a partial explanation of the peculiar distribution of adult oysters in the intertidal zone.

The direct effects of predators such as oyster drills and secondary effects of heavy growths of various sessile organisms, which compete for space and may cause additional mortalities, has been noted. The rate of mortality caused by oyster drills may be greater than these results indicate because the use of a chain to which the baskets were attached would hinder the ascent of drills.

The light sets of oysters at Core Creek and the Institute pier compared to the heavy sets at the other stations suggest the possible influence of currents upon setting. At the Institute pier the set of oysters in the vertical distribution series was light compared to the sets obtained along the shore in the intertidal zone, where daily and weekly data are collected. The average set of oysters along the shore during the same period was nearly five times greater than the set at any level of the vertical distribution studies.

The need for further studies of the effects of current upon setting and the effects of predators and fouling organisms upon survival is evident before an explanation can be made of the limited distribution of adult oysters to the intertidal zone.

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A Preliminary Report on Some Experiments in the Production and Transplanting of South Carolina Seed Oysters to Certain Waters of the Chesapeake Area

PART 1: Production of Oyster Seed

G. Robert Lunz

Director Bears Bluff Laboratories, Wadmalaw Is., S. C.

In 1948 Mr. G. Francis Beaven of the Chesapeake Biological Laboratory transplanted a small sample of South Carolina oysters to Maryland. He made careful studies on the survival and growth of these oysters. Generally speaking, the results were fairly satisfactory, but viewed in its entirety, the experiment could not be called successful enough to attempt a commercial venture. However, this earlier transplanting by Beaven made use of mature oysters. It seemed possible to us that at this age these oysters were "set in their ways" and could not stand moving. Therefore, in 1950 some month-old oysters were moved from Bears Bluff to Maryland. These oysters survived and thrived sufficiently well to encourage us to continue our experiment. Since then several truck loads of seed oysters have been shipped from Bears Bluff to Maryland for experimental purposes. Plantings have been made in numerous locations throughout the Chesapeake Bay region. Mr. Beaven will report on the results of these transplantings from studies made by him, by Fred Sieling, Joe Manning, and Dr. Jay Andrews.

The purpose of my part in this discussion is to show at what cost we in South Carolina can secure seed oysters for shipment.

Without the long-winded supporting data and experiments to prove the point, please accept the statement that it seems more economical and better for all around purposes to use shell cultch in wire baskets. These baskets are made from poultry netting and hold about a half bushel of shell. By using a large knife-like cutter similar to a photographer's trimming board, and by stapling the edges of the wire together with a P-7 Bostitch stapler, these baskets can be manufactured for 18.2 cents apiece.

South Carolina waters are so heavily laden with oyster larvae, and setting is so uniformly good from May through September, that it is not necessary to expose these cultch bags on existing oyster beds. It has proven quite practical to suspend these baskets from steel cables hung along the edge of a small creek by the Laboratories over soft unproductive muddy bottoms. The cables are stretched between piling in such a way that the cultch bags hang at an elevation of from plus one to plus two feet. This elevation is exceptionally good for securing relatively heavy set of young oysters.

By making use of cables suspended over soft muddy bottoms, any criticism of utilizing existing, productive, oyster beds and diverting them to this proposed seed oyster business is eliminated. Surprisingly enough, such criticism has come from commercial oystermen, conservationists, and extremely provincial individuals.

The entire operation of making the baskets, filling them with shell, suspending the bags on the cable, collecting the seed and delivering the seed oyster bags on the dock, was done at a cost of roughly from twenty-one to twenty-two cents a bag. Seed oysters can be produced thus from the latter part of May until well into September. Within two months after exposure,

spat usually will be thumb-nail size, and normally, after four months, they are about the size of a half dollar.

These bags can be readily transported to the Chesapeake Bay area. They make handling of seed oysters easy because the entire bag can be loaded aboard the boat for planting. Once on the planting grounds, the staple rings can be cut loose with a wirecutting pliers and the cultch, with seed, dumped from the boat on the planting grounds. Mr. Beaven will doubtless outline to you some of the results of the transplantings, but, from correspondence with him, it is my understanding that we have found that this seed could remain exposed as long as six days from the time they were landed on our docks until the time they were planted in the Chesapeake area. Doubtless this time would vary somewhat according to temperatures.

If these seed oysters grow successfully in northern waters, South Carolina could readily supply a large part of the demand. Investigation shows that over and above the legal amount required for replanting, roughly 300,000 standard bushels of shell are available for cultch annually.

One of the important questions is, however, would it be a profitable venture? At present South Carolina places a tax of ten cents a bushel, *or fraction thereof*, on all oysters in the shell shipped within or out of the State. Since the experimental shell bags are approximately a half bushel, each bag would have a ten cents tax placed on it. Transportation costs are another drawback. Ordinary common carrier transportation rates would run about $3.50 a hundred from Bears Bluff Laboratories in South Carolina to the Chesapeake Biological Laboratory at Solomons, Maryland. Since these half-bushel wire baskets weigh approximately fifteen pounds, the cost of transportation would be about fifty-three cents per bag. Thus, until something can be done to lower the transportation cost, it is quite obvious that it would not be economically feasible to ship seed oysters from South Carolina to the Chesapeake Bay area. However, it seems likely that a cheaper means of transportation can be found. Water transportation has not yet been investigated. Another reduction in the cost of production of seed oyster baskets could be in the reduction of taxes. It is not illogical to assume that the General Assembly could be persuaded that it would be to the State's advantage to Collect some tax at a lower rate than little or no tax at a high rate. To still further reduce the cost it has been found practical to use the cultch bags twice. Some would be lost, but a large percentage could be returned by the oysterman.

To summarise in tabular form the cost of production of the seed oysters in South Carolina, consider this table:

Cost of Bag	7.7 cents
Labor, manufacture of bag	6.0
Cost of shell	1.5
Labor for filling bag	3.0
Labor, handling to and from cables	2.8
Cost per bag	21.0 cents
Tax	10.0
Freight	53.0
Total cost per bag	84.0 cents

Since it is understood that the demand for seed oysters in the Chesapeake Bay area and in other northern waters is almost unlimited, and since South Carolina has available 300,000 bushels of shell yearly, it is theoretically possible to ship over 500,000 seed bags from South Carolina each year. A bag of seed oysters of the size used in these experiments will sell for about fifty cents. In a large scale venture the cost of shell bags could be reduced somewhat. Taxes can certainly be reduced. Lower costs can be had in re-use of the wire baskets. If transportation can be had reasonably enough, a new phase of the oyster industry may be possible in South Carolina provided the South Carolina seed grow and survive sufficiently to satisfy the demands of oystermen in the Chesapeake Bay area. Mr. Beaven has been working on this phase of our problem and he will now discuss with you the survival and growth of South Carolina seed in northern waters.

A Preliminary Report on Some Experiments in the Production and Transplanting of South Carolina Seed Oysters to Certain Waters of the Chesapeake Area

PART 2: The seed problem in Maryland and some observations on the survival and growth of South Carolina spat when transplanted experimentally to different type areas in the Maryland-Virginia region.

G. Francis Beaven

Department of Research and Education, Solomons, Maryland

One of the greatest problems of oyster production in the Maryland area, as in many states further north, is that of securing a sufficient supply of seed oysters. Natural setting over many bars in this region usually is too light to replace the market oysters harvested by conventional methods. This lack of spat favors the growth of well shaped, fat single oysters but makes it necessary that either the rate of harvesting be greatly restricted or that the bars be reseeded periodically in order to maintain their production. Where such conditions prevail private planters have found that the greatest profits can be realized through harvesting by the most efficient means possible and then reseeding the bottom for each succeeding crop. An essential factor in the success of such a system, however, is the ability to obtain an ample and dependable source of seed oysters. This has become increasingly difficult in recent years. A similar problem is faced by the State in its management of the publicly worked natural rocks.

Extensive supplies of small or seed oysters once were found on the natural beds in the upper part of Chesapeake Bay and in the upper Potomac River. These have been destroyed almost completely by recurring freshets during recent years. Even if oysters again become reestablished on these upstream beds the supply there still would remain undependable. The famed James River seed beds in Virginia long have been a major source of seed for Maryland planters. For the past few years, however, the sale of seed from these beds has been banned periodically to out-of-state buyers. Pamlico Sound once also was an important source of seed planted in Maryland but the supply became badly depleted and the sale of seed was restricted a number of years ago. Present

seed sources include Delaware Bay, private plantings in Virginia, limited sales of seed by the State from public areas, and low priced market oysters from natural rocks. Planters in Chincoteague Bay at times buy large-sized seed from Long Island growers. Occasional plantings of cluster oysters from South Carolina reefs have been tried but have failed to do well. Additional seed sources are being sought and are urgently needed.

The use of newly-set spat as seed oysters has become an accepted practice in Maryland only during recent years. Planters formerly demanded a fairly large seed oyster, typically two to three inches in length. These were planted in early spring and left to grow for only one or two seasons before they were harvested. Yields seldom were better than one for one. On the type of bottom commonly available to Maryland planters small single seed oysters tend to settle and become smothered so that they may yield even less than plantings of larger sized seed.

About ten years ago the State first began to concentrate a considerable portion of its shell plantings in certain limited high setting areas for the express purpose of producing seed oysters to be replanted on other bars. These shells with quantities of young spat attached are taken up and scattered on good growing bottoms during the following fall or spring months. Such seed are known as "shell plants." The excellent yields provided by this type of seed soon interested private growers in its use. A shell encrusted with spat will stand up on bottoms where small single oysters will sink. Since the count of spat per bushel may run quite high, such seed, when planted thinly, may yield several bushels of oysters for each bushel of seed. Unfortunately, only limited areas have been found in Maryland where sets are consistantly high enough to produce good quality shell plants and these areas are not available for leasing to private planters.

The ability of South Carolina to produce seed oysters of the shell plant type, in quantity and at compartively low costs, offers the possibility of a trade profitable to both the producer and planter provided that such seed would thrive under the conditions found in the Chesapeake area. Preliminary observations of experimental plantings of southern seed oysters in Maryland waters had indicated that fairly good survival and growth is possible in certain cases although no seed of this particular type has been tried. It was felt that transplanting as spat might enable the oysters to become more easily adjusted to new conditions and that natural selection after transplanting would result in the survival of those best suited to the new environment.

Oyster growing conditions in most of the Chesapeake area are quite different from those on the intertidal reefs of South Carolina. In Maryland oyster bottoms are of various textures and usually continuously submerged. Tidal amplitudes generally are less than two feet, ranging from a few inches to a little over three feet. Strong winds cause the greatest tidal variations and may result in shallow flats at times being exposed for several days during winter storms. Waterways typically are broad and margined by sandy beaches where pounding waves prevent the establishment of oysters in the immediate vicinity of the shore line. For these reasons few oysters are found growing intertidally. Depth of water over the oyster bars may range from a few inches in sheltered coves to over a hundred feet in one instance. Maximum depths of oyster bars, however, seldom exceeds forty feet.

Most of the Maryland half of Chesapeake Bay and the greater part of its tributaries have prevailing salinities of less than half that of open sea water. Oysters are found where salinities at times reach zero and seldom rise above ten parts per thousand, or a little less than one third that of sea water. In the upper Bay salinities are consistantly low rather than fluctuating from near zero to rather high values as is characteristic of many of the southern coastal estuaries subject to periodic flooding. On the deeper rocks of Tangier Sound and in the Virginia portion of the Bay salinities range above half that of sea water and oyster drills there become a serious problem. In the shallow waters of Chincoteague Bay along the Maryland-Virginia coast salinities usually approach that of sea water and may become even higher during hot dry spells. Water temperatures range from near freezing in mid winter to the low thirties (on the Centigrade scale) in mid-summer.

The first South Carolina spat on planted shell transplanted to Maryland waters at Solomons consisted of only two shells brought up by Mr. G. Robert Lunz of the Bears Bluff Laboratories on a business trip in July of 1950. These were planted on a tray in shallow water. The spat on them showed such rapid growth and good survival during the remainder of the summer and all months that enthusiasm became high over their possible use as seed.

During November of 1950 a number of bags of late summer South Carolina set were transported to Solomons by truck and then distributed to several locations typical of the oyster growing areas in the Maryland portion of the Chesapeake. All of these seed oysters were planted on trays and in most cases left undisturbed until late winter or the following spring. The seed were out of water for two days during transportation. At Solomons one tray was held out for three additional days and a second for seven additional days in order to observe the losses which might be caused by delays in transportation.

Most of the trays were left undisturbed until the following spring although those at Solomons were examined at more frequent intervals. A number of the trays were lost but those remaining presented a very disappointing picture of survival under the conditions of the experiment. A summary of the pertinent results is shown in Table 1.

TABLE 1

Survival of S. C. We Creek 1950 Transplants

Planting location	Survival January 1951	Survival May 1951
Solomons, 2 shells July	99%	6%
7 areas above Solomons, Nov. 3		0
Solomons, Nov. 3	over 90%	1%
Solomons, Nov. 6	over 90%	2%
Solomons, Nov. 10	approx. 1%	0 + (1 oyster)
Crisfield, Nov. 4		12% approx.

All of the seed plantings above Solomons, which is about median in salinity conditions for the Maryland area of the Chesapeake, showed no surviving oysters. At Solomons too few survived to be of significance as seed except on the two shells in July which still had a few living oysters on each shell. At Crisfield survival was slightly better but still unsatisfactory. There the salinity was higher and the tray had been accidentally placed where it was partially

exposed at low water. Holding the seed out of water for five days prior to planting at Solomons caused no significant loss but oysters left out for nine days were nearly all dead at the time of the first examination.

In spite of the poor results of this first experiment it seemed possible that better survival might be obtained if seed were moved in mid-summer or if they were planted in waters of higher salinity. There also was the possibility that intertidal exposure might be a factor in the survival of seed of this type. For these reasons a second experiment was tried in which part of the seed were planted during mid-summer and in areas having higher salinities. A group of plantings was made in late fall in which comparisons were possible between South Carolina intertidal seed, South Carolina seed produced on submerged bottom, local Chesapeake seed and seed from the intertidal flats at Chincoteague Island.

TABLE 2

Survival of July 1951 We Creek Seed

Location	Mid Winter	March	May	Oct.	Length
Solomons, Md.	est. + 90%	67%	43%	good	59.4 mm.
Upper Patuxent	est. + 90%	66%		fair	59.4 mm.
Gl. Pt. Va. open*	0%	all drilled			
Gl. Pt. Va. prot.*	87% (51 mm.)	80%	74%	69%	68.4 mm.
Chinc. Is. submerged	nearly all drilled			0	
Chinc. Is. intertidal	nearly 100%	nearly 100%		all top mat of 3" + coon oysters	

* Oysters singled

Table 2 summarizes essential results from the July transplanting of 1951. Survival and growth in late summer and fall were excellent at Solomons and at all of the other locations except where drill damage was high. The Virginia Fisheries Laboratory at Gloucester Point singled up two groups of the oysters and kept very careful records of growth and mortality at frequent intervals. At this location it was found that the mortality rate among South Carolina seed compared with James River seed, when protected from drills, was significantly greater during the winter months but less during the summer months. Oysters in the tray open or unprotected from drills at Gloucester Pt. proved very attractive as drill bait as did the submerged tray at Chincoteague Island. Average lengths measured in October 1952 are given in the last column. Measurements of the clusters of seed at Solomons were taken from the oysters on the upper surfaces of the shells. Exceptionally good growth occured at Gloucester Pt., especially during the first summer and fall. At Chincoteague Island the intertidal tray, though thinly planted, required an additional thinning to just a few shells in the spring of 1952. In spite of this, such excellent survival and growth occured that the oysters became too matted together to separate and measure in October. Survival among the different groups was poorest in low salinity areas and best at the higher salinities.

Engagements in other work caused postponement of the 1951 fall planting of seed until the first of December. A summary of the survival of South Carolina intertidal seed of this planting is shown in Table 3.

TABLE 3

Survival of We Creek Seed Transplanted Dec. 1

Location	Mid Winter	March	May	Oct.	Length
Solomons, Md.	94%	35%	1%		
Upper Patuxent		4%		....	
Chincoteague Is.,* submerged		53%	16%	all drilled	
Chincoteague Is.,* intertidal		67%	54%	good	58.0 mm.
Ocean City,* submerged			9%	lost	
Ocean City,* intertidal			11% (some buried)	lost	
Mid Chincoteague* Bay submerged	88%		85%	excel'nt	63.7 mm.

* Nearly all loss caused by drills.

At Solomons and up-river from Solomons an almost complete mortality ccured during late winter and early spring. Poor survival at the Ocean City nlet is attributed to wind occasioned low tides which left the trays exposed or several days in freezing weather. These trays later were tampered with and ost. Drills again destroyed the submerged seed at Chincoteague Island and ppeared to be the chief cause for losses in the other Chincoteague area plant·gs. At the plantings mid way up Chincoteague Bay survival was best and rowth excellent.

TABLE 4

Survival of Different Seed at Solomons, Md.

Source of Seed	Mid Winter	March	May	Oct.	Length
We Creek—July	est. + 90%	67%	43% (35mm.)	good	59.4 mm.
We Creek—Dec. 1	94%	35%	1%		
Ashepoo—Dec. 1	86%	32%	10%	....	
Chinc.—Dec. 1	92%	70%	66%	fair	mixed age
St. Marys—Dec. 1	95%	lost	lost		
St. Marys—early spring				good	49.3 mm.
In Upper Patuxent River					
We Creek—July	est. + 90%	66%		fair	59.4 mm.
We Creek—Dec. 1		4%		....	
Ashepoo—Dec. 1		3%		....	
Chinc.—Dec. 1		11%		very poor	47.0 mm.
St. Marys—Dec. 1		87%		excellent	55.5 mm.

Table 4 compares seed from different sources which were planted at Solo·ns and up-river from Solomons. The Ashepoo seed was produced in sub·rged South Carolina waters of lower salinity than the intertidal area at We reek. Spat on these shells were small and scattered. The upper Patuxent pically produces a better growth of local seed than at Solomons. This was not e case with the South Carolina seed although at both locations it somewhat ceeded the size of the native St. Marys River seed. The Chincoteague inter·dal seed showed a much better survival at Solomons than that from We

Creek but proved quite poor at the upper station. St. Marys River seed survived and grew better at the upper station than at Solomons, and showed the least mortality at both locations.

TABLE 5

Survival of Different Seed at Chincoteague Is. Planted Dec. 1 or a Little Later

Source	Type Planting	March	May	October	Length
We Creek	intertidal	65%		53%	58.0 mm.
We Creek	submerged	53%	16%	rep. all drilled	lost
Ashepoo	intertidal	67%	54%	41%	47.5 mm.
Ashepoo	submerged	21%	2%	rep. all drilled	lost
Chincoteague	intertidal	92%	92%	excellent	mixed year classes
Chincoteague	submerged	16%	1%	rep. all drilled	lost
St. Marys	intertidal	100%	99%	99%	(older seed)
St. Marys	submerged	98%	14%	rep. all drilled	lost

Table 5 compares the same types of seed as Table 4, when planted at Chincoteague Island intertidally and submerged. Some of the seed in this case was first placed temporarily on submerged trays in the central Chincoteague Bay and shortly afterward moved to permanent locations at Chincoteague Island. Here again all submerged seed was reported to have been drilled prior to the October examination. The South Carolina intertidal seed appears to have survived and grown quite well in the intertidal zone. Unfortunately, exact comparisons with local seed could not be made since seed of the same year class was not obtained in this case.

TABLE 6

Survival of Different Seed in Mid Chincoteague Bay Area—Submerged

Source	March	May	October	Length
We Creek	88%	85%	good	63.7 mm.
Ashepoo	75%	70%	fair	51.1 mm.
Chincoteague	89%	82%	good	mixed age
St. Marys	94%	88%	good	larger seed

Table 6 shows that the South Carolina intertidal seed survived quite well and made exceptionally good growth when submerged in the mid Chincoteague Bay area. Drills apparently caused most of the losses here but were not nearly so destructive as at Chincoteague Island.

The data gathered thus far are not nearly as complete as desired but do seem to indicate some tentative conclusions. Survival of South Carolina seed under the conditions of the experiments has been decidedly poor in the upper portions of the Chesapeake oyster producing areas, good in the lower Chesapeake and excellent in the Chincoteague area, exclusive of drill damage. There is evidence that this difference in survival rate is more dependent upon salinity conditions than upon other factors.

The accompanying graph (Figure 1) shows the average and extreme conditions of temperature and salinity which were recorded at Solomons during the

time of the experiments. During both 1951 and 1952 winter and spring salinities were lower than usual while temperature conditions showed little variation from normal. Daily records of conditions at Gloucester Point are not at hand but data published by the Chesapeake Bay Institute for the same period indicate that salinities at Gloucester Point will run about seven parts per thousand higher than at Solomons, during the season of lowest values. Differences in water temperatures at the two locations are too slight to appear significant. Weekly records from the Chincoteague area show salinities ranging from about 23 to 32 parts per thousand during the time of the experiments. Typically they remain at high levels most of the time with quick recovery after the occasional drops caused by heavy local rainfall.

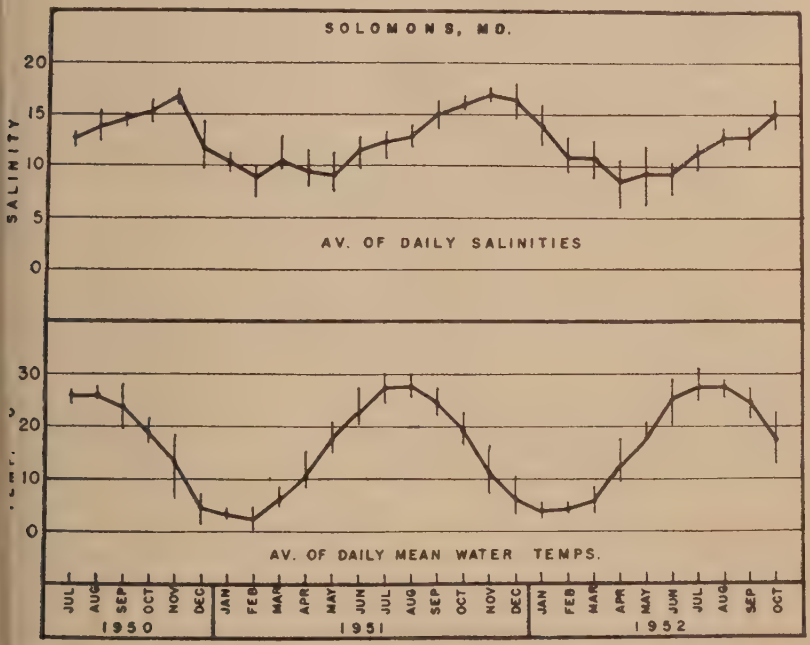

FIGURE 1. Averages of daily salinities and daily mean water temperatures, Solomons, Md., 1950, 1951 and 1952.

Temperatures of the shallow Chincoteague water fluctuated more abruptly than in the Chesapeake and during the winter at times were near freezing with some ice formation. The average temperatures, however, appear to be little different from those of the Chesapeake area.

South Carolina intertidal seed in its native habitat is subjected to considerable temperature variations, especially when exposed at low tide, but is not subjected to long periods of low salinity. At Solomons the South Carolina seed was exposed to a long period of much lower salinities and of lower water temperatures than normally occur in its native habitat. The fact that low temperatures and depressed salinity were both experienced at the same time probably made survival more difficult. The lower salinities at Solomons and at

further up-stream locations appear to be the principal cause of poor survival of South Carolina seed in those areas as compared with Gloucester Point and Chincoteague Bay.

Further observations of the continued survival and growth of South Carolina seed planted in the Chesapeake area are needed in order to evaluate its potentialities for commercial use. Indications drawn from the present data may be summarized as follows:

(1) South Carolina intertidal seed transplanted during the summer months survives better in the less favorable of the habitats tried than does similar seed transplanted in late fall.

(2) Such seed has shown better survival and growth in the lower Chesapeake area than at Solomons or above, and has survived still better in the Chincoteague area.

(3) Destruction of small seed of this type by drills in infested areas is a serious problem and may limit its usefulness.

(4) Survival and growth appear to be as good in submerged plantings as in intertidal plantings except where drill infestation is heavy.

(5) The South Carolina seed produced on submerged shells in the Ashepoo River had fewer spat per shell, survived no better, and showed less rapid growth than the intertidal seed.

(6) Growth in length of the South Carolina intertidal seed generally has been more rapid than that of the other seed with which it was compared.

(7) Crowding of oysters on the South Carolina shells necessitates very thin planting and may result in poorly shaped oysters. Thinning at about one year of age would materially improve the resulting market oysters.

The observations here reported upon have been made possible through the cooperation and assistance of the following: Mr. G. Robert Lunz, Director of the Bears Bluff Laboratories, and his staff; Dr. Jay D. Andrews, oyster biologist of the Virginia Fisheries Laboratory; Dr. J. L. McHugh, Director of the Virginia Fisheries Laboratory; Inspector Steelman and his son at Chincoteague, Va.; Mr. Fred W. Sieling, biologist in charge of Chincoteague Bay Investigations; Mr. Joseph H. Manning, oyster biologist at Solomons; and Mr. Harvey Mister of the laboratory staff at Solomons.

Quantitative Measurement of Effect on Oysters of Disease Caused by "Dermocystidium marinum"[1]

Sammy Ray, *Rice Institute, Houston, Texas;* J. G. Mackin *and* James L. Boswell, *Texas A. and M. College, College Station, Texas*

ABSTRACT

Measurement of effect of the *Dermocystidium* mycosis in terms of weight of oyster meats has been accomplished by analysis of measurements of meat weights and shell capacity of 508 oysters over a period extending from April, 1952, to August, 1952. The 508 oysters included 198 heavily infected with *D. marinum*, 83 moderately infected, and 227 either lightly infected or

1 Published in Bulletin of Marine Science of the Gulf & Caribbean, Vol. 3 No. 1.

negative. Weights of meats of heavily infected oysters and moderately infected oysters are compared, per unit of shell capacity, with the negative and lightly infected group. The data show that the average mean of meat weights of heavily infected oysters was about 33 per cent less than that of the controls and that the moderately infected oysters were intermediate in loss of weight. Mathematical analyses of the data support the conclusion that disease plays a major role in reduction of meat weights.

Analysis of the data also shows that reduction of weights is not only a matter of disease but of season, summer losses accruing from disease being significantly greater than those of early spring months.

Experimental studies which eliminate factors of nutrition point to lysis of tissues as one of the major processes resulting in loss of weight. In these studies reduction of bits of excised gill tissues which were heavily infected with the fungus is compared with that of normal excised tissues when bacterial and other contaminants are excluded.

Statistical methods and procedures are fully described.

Distribution of Oyster Larvae in Relation to Hydrographic Conditions

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Chesapeake Bay Institute
The Johns Hopkins University

Observed Distribution of Salinity and Circulation Pattern

In the summer of 1950 the Chesapeake Bay Institute of The Johns Hopkins University, in cooperation with the Virginia Fisheries Laboratory, undertook an intensive study of the physical and chemical hydrology of the James River oyster seed bed area. A detailed discussion of the observed current velocities and salinities is presented elsewhere (Pritchard, 1952). The discussion here will concern the circulation pattern and mixing processes, as indicated by the observations of velocity and salinity.

First, consider briefly the character of the salinity distribution. Figures 1 and 2 show the surface salinity distribution over the seed bed area of the James River for low and high water, respectively, on September 2, 1950. The following common features are noted: (1) an increase in salinity from the head of the estuary, where the fresh water enters, toward the mouth; (2) a salinity gradient across the estuary with higher salinities on the left side of the estuary than on the right side (directions are taken relative to an observer standing at the head of the estuary and facing toward the mouth); (3) the tidal fluctuation does not greatly alter the general picture, but rather shifts the pattern up and down the estuary.

In Figure 3 examples of the vertical distribution of salinity are given. These mean salinity vs. depth curves are similar to an inverse tangent function, with an upper and lower layer of slight vertical gradients separated by a halocline of relatively rapid change in salt content with depth. At the bottom, and to some extent at the surface, the curve shows increased gradients apparently related to boundary effects. The character of the vertical distribution does not change greatly with longitudinal distance. Consequently, the horizontal gradients do not vary appreciably with depth.

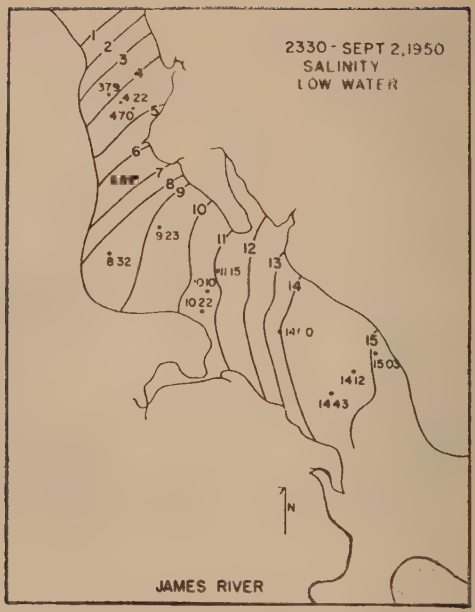

FIGURE 1

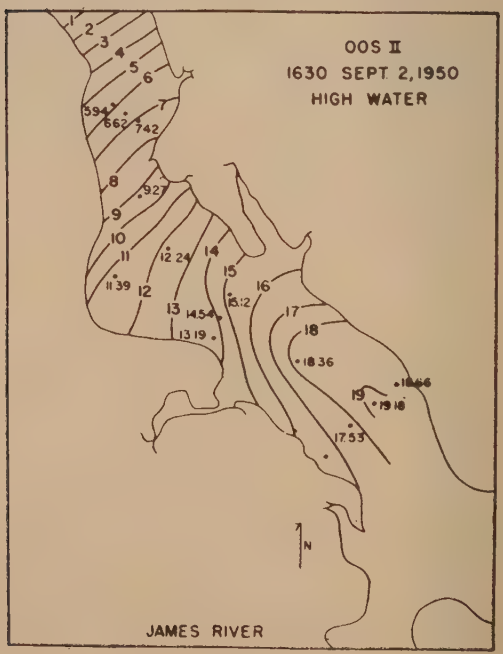

FIGURE 2

The most obvious water movements in the James River estuary are oscillatory tidal currents. Time averages of hourly current observations taken over one or more tidal cycles reveal that superimposed upon the oscillatory tidal currents is a net circulation pattern which appears from investigations of other estuaries of the Atlantic Seaboard to be typical of many coastal plain estuaries at mid-latitudes.

Currents which are directed upstream toward the head of the estuary are designated as flood currents, while those directed toward the mouth of the estuary are designated as ebb currents. If the magnitudes of all ebb current velocities taken at a single station over several tidal cycles are averaged and plotted against depth, a graphical presentation of the mean vertical distribution of ebb velocities is obtained. The mean vertical distribution of flood velocities may be obtained in a similar manner. Figure 4 gives such a presentation for three different periods of observation at a typical station near the center of the James River estuary. The ebb velocities are relatively large at the surface, and decrease with depth, while the flood velocities are relatively small at the surface, but increase to a depth of about 17 feet where the influence of bottom friction results in a decrease in magnitude as the bottom is approached. The two sets of curves cross at about ten feet where the magnitude of the mean ebb current is the same as the magnitude of the mean flood current.

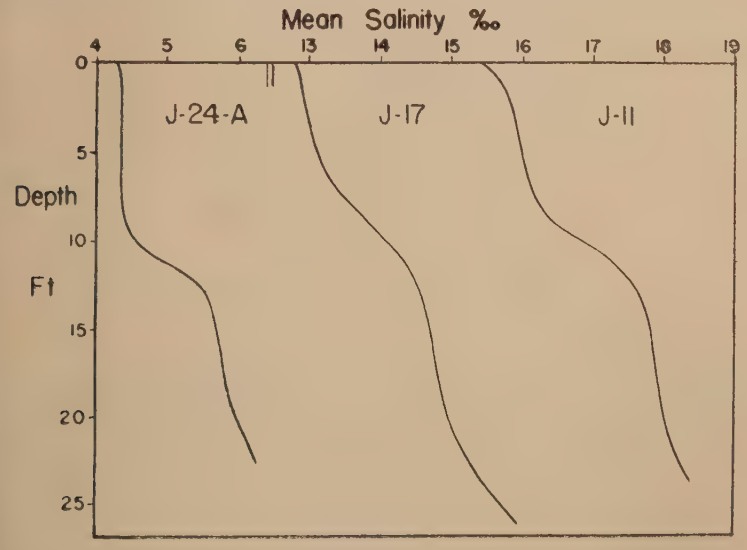

FIGURE 3

Averaging of the ebb and flood current observations together results in the net velocity-depth curves shown in Figure 5. Above ten feet in depth the current is directed down the estuary and is designated as positive. Below ten feet the current is directed up the estuary and is designated as negative.

The boundary between the surface layers which have a net movement down the estuary and the deeper layers which have a net movement up the estuary

may be designated as a surface of no net motion. The depth of this surfac varies slightly both in the longitudinal and in the lateral direction. Figure shows a cross-section of the James River estuary upon which the observe surface of no net motion has been drawn. The figure reveals that this surfac slopes downward from the left side of the estuary toward the right side. Th results in a deeper layer of positive flow on the right side, where the mea salinity is low, than on the left side, where the mean salinity is high.

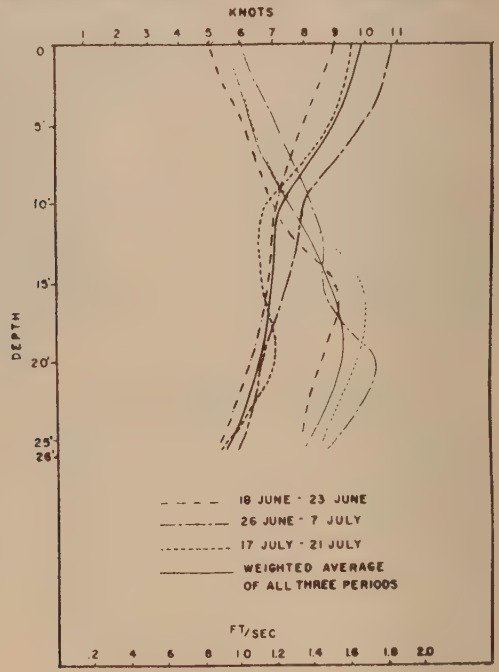

FIGURE 4

From the standpoint of the distribution of salinity and of the circulatio pattern the James River estuary may be considered as composed of two layer In the upper layer there is a net horizontal flow down the estuary. In th lower layer there is a net horizontal flow up the estuary. The upper layer ha a lower mean salt content than the deeper layer. In order to maintain volum continuity, there must pass through each section seaward during any perio of time an amount of fresh water equal to the amount of fresh water intro duced from the river during that time interval (neglecting evaporation fro and precipitation on the surface of the estuary itself). Thus, since the upp layer is transporting seaward a net amount of fresh water equal to the fres water inflow, there must be a flux of salt into the upper layer to maintai the salinity distribution. This may be accomplished by two processes: (1) net transfer of relatively higher salinity water from the lower layer to th upper layer, resulting in a net vertical velocity directed upward across th boundary between the two layers; and (2) a random flux of salt upward du

to eddy turbulence. The first process leads to an augmentation of the volume of flow in the lower layer.

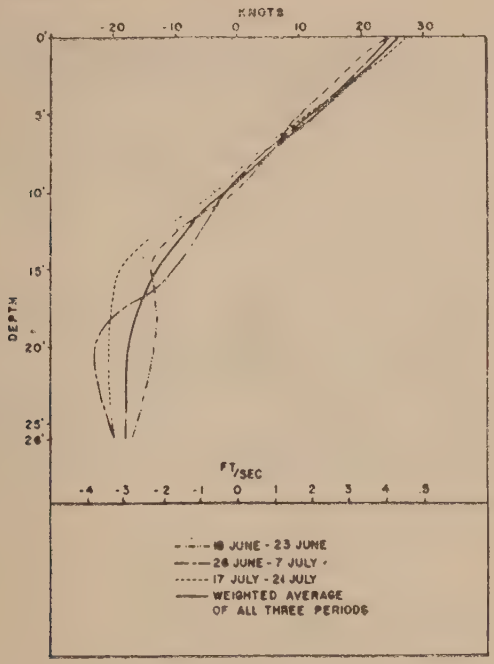

FIGURE 5

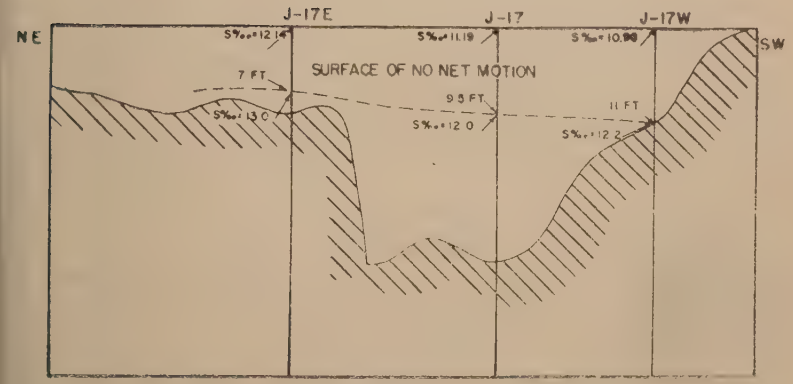

FIGURE 6

A schematic presentation of the flow pattern in a vertical section taken along the central axis of the James River estuary is given in Figure 7.

FIGURE 7

The Mixing Processes

It is beyond the scope of the paper to present the complete theoretical development required to obtain the magnitude of the mixing processes which contribute to maintaining the distribution of dissolved and suspended material in the James River. The principles involved will be briefly discussed.

The mean time rate of change of concentration of any material in solution or in true suspension in a natural body of water is given by the sum of the spacial derivatives of the mean advective flux and the non-advective flux of the material in question. Thus, in the case of salt content, the equation giving the mean time rate of change is

$$\partial \bar{s} / \partial t = - \frac{\partial}{\partial x_i} (\bar{v}_i \bar{s}) - \frac{\partial}{\partial x_i} \langle v_i' s' \rangle$$

where s is salt concentration, t is time, v_i is vector velocity (having the three components v_1, v_2, and v_3) and x_i represents the three spacial coordinates x_1, x_2, and x_3. The superscript — and the symbol $\langle\ \rangle$ both indicate time averages. The instantaneous salt concentration s is considered to be composed of a mean concentration $\bar{s}$ plus a random concentration s'. Similarly the velocity v_i is composed of a mean velocity $\bar{v}_i$ plus a random velocity v_i'.

The term $\bar{v}_i \bar{s}$ represents the mean advective flux of salt, and can readily be obtained from observations of salt content and velocity. The term $\langle v_i' s' \rangle$ represents the non-advective flux of salt, and cannot be readily determined directly because the spectrum of random velocities contains turbulent components having the time and space which are below the sensing ability of present day marine instrumentation. Pritchard (1952) has shown, however, that an adequate application of boundary conditions allows the indirect determination of the non-advective flux by employing the observed mean salinities and velocities in a modified form of equation (1). The modifications employed are based upon simplifying considerations peculiar to a coastal plain estuary as the James River.

The non-advective flux term $\langle v_i' s' \rangle$ is more generally called eddy diffusion and expressed as $-A_i \partial \bar{s} / \partial x_i$, where A_i is the so-called diffusivity or Austausch coefficient. If it is assumed that the mixing processes are such that the diffusivity is the same for all dissolved or suspended substances, then the results of the evaluation of the salt balance provides information required to predict the time change of any dissolved or suspended material carried by

the water. In a practical application it is of course necessary to make some reasonable assumption as to the initial distribution of the material.

The results of studies in the James River estuary have shown that the salt balance is maintained primarily by two processes—the mean horizontal advection and the vertical mixing term. Of secondary but still significant importance is the mean vertical advection term. The horizontal mixing term is not important in maintaining the salt balance in the James River.

Application to Oyster Larvae Distribution

The application of the general principles of circulation and mixing in the James River to oyster larvae distribution is encouraging. Oyster biologists have long pondered about the processes whereby oyster larvae apparently move "upstream" from beds of mature oysters to setting bars further up an estuary. The net movement of the deeper layers provides a mechanism for this up-estuary movement of the larvae.

There is no agreement as yet as to whether the oyster larvae which produce the profitable set of seed oysters in the James River originate from mature oysters in the immediate vicinity of the seed beds, or whether the supply is from further down the estuary, for example, from the mature oysters in the Hampton Roads area. Every few years the oyster population in the portion of the seed bed nearest the head of the estuary is destroyed by freshets. The return flow of the deeper layers provides a mechanism for the replenishment of these beds from the surviving bars further downstream.

Another feature of the circulation pattern appears to be related to the distribution of seed oysters, and consequently to the distribution of oyster larvae. As mentioned above, the upper boundary of the sub-surface layers of water having a net motion toward the head of the estuary occurs at shallower depths on the left side of the estuary than on the right side. This lateral distribution of the net motion implies a slow upwelling of the deeper waters over the shallow bars of the northeast side of the river. Thus oyster larvae brought up the estuary in the deeper layers would tend to be concentrated over the bars on the northeast side. Dr. Jay Andrews has reported that the northeast side of the river has much higher production of oyster seed than the southwest shore.

Bousfield (1952) in a recent paper before the American Society of Limnology and Oceanography described the distribution of barnacle larvae in Miramichi Estuary. This estuary is remarkably similar in physical structure to the James River. Bousfield made use of the above described studies on the James River in explaining the observed distribution of the larvae in Miramichi Esturay.

Mr. Bousfield kindly sent the writer some of the illustrations from his treatise prior to publication. A portion of one of his graphs is presented in Figure 8. A vertical-longitudinal section of Miramichi Estuary is shown, running from the fresh water in the river on the left to the mouth of the estuary on the right. At selected stations along this section the vertical distribution of the larvae of *Balanus improvisus* is shown by the shaded areas. In the upper section the distribution of the early stages I and II is given. In the lower section the distribution of the late Cyprid stage is shown. It is seen that the early stages are concentrated in the surface layers and are found

in the lower portion of the estuary. The late stage occurs in greater concentrations below mid-depth and is found further up the estuary.

Bousfield, by comparison with the James River study, has estimated that the surface of no net motion occurs at about nine feet. Above this depth, as described above, the net flow is directed down the estuary toward the sea, and would carry those larvae which remained in this layer out of the estuary. At depths greater than nine feet, however, the net flow would be directed up the estuary, and hence carry the larvae in this layer away from the mouth up into the estuary.

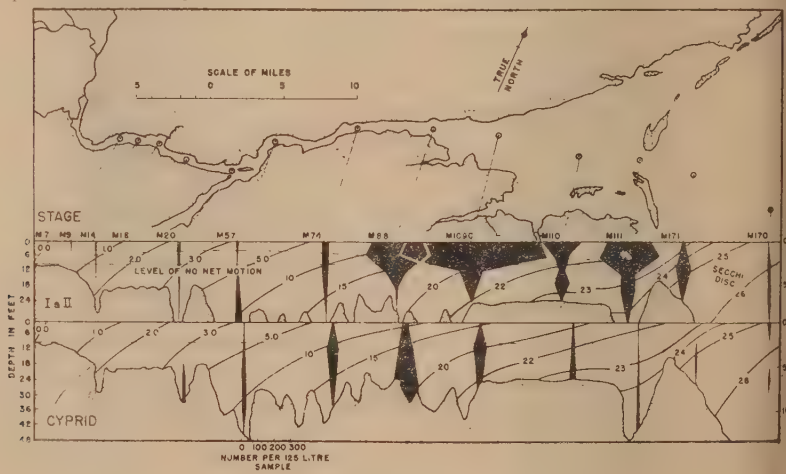

FIGURE 8

The observed distribution of oyster larvae in the James River estuary has not revealed any such clear-cut vertical relationship as described for the barnacle larvae in Miramichi Estuary, even though the hydrography has been more precisely defined. It is believed that the reason for this is related to our inability, to date, to sample adequately the larvae distribution, particularly the late stage larvae. Even though setting in the James River is very high, calculations show that the concentration of late stage larvae in the overlying water sufficient to produce the large observed set needs to be, on the average, only about one larva per 100 liters. Since the basic sample employed in filtering out the larvae was 100 liters, it is apparent that a clear picture of the relative distribution of the late stage larvae could not be obtained by our sampling procedures.

Specific applications of the results of our theoretical study of circulation and mixing to observed distributions of oyster larvae have met with less success than might be hoped for on the basis of the above qualitative relationships. During our study of the James River estuary in the summer of 195 samples were obtained for the purpose of determining the distribution of oyster larvae. The counting of the oyster larvae in such samples is a tedious and time-consuming task, and only one series of observations are as yet available for our consideration. Dr. Andrews has kindly made available the series which was obtained at the surface over the Wreck Shoal oyster bar

The samples were collected at aproximately two hourly intervals during the period August 31 to September 3, 1950. The observed hourly current velocities have been employed in converting this time series of observations to an approximate spacial distribution.

In Figure 9 a portion of the series has been plotted against longitudinal distance from the Wreck Shoal station for the high water slack and for the low water slack nearest the time of the observation. It is possible in many cases

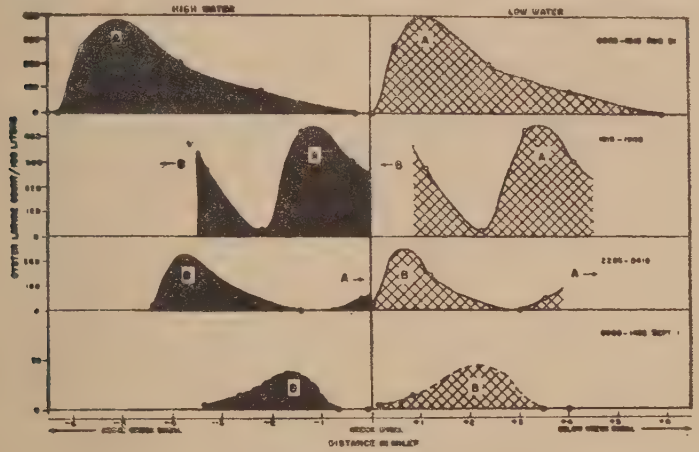

FIGURE 9

to identify peak concentrations of the oyster larvae as these concentrations move downstream past the station. It should be borne in mind that this plot represents but one dimension of a three-dimensional distribution. During the period between one high water slack and the next the processes of mixing alter the distribution. For these reasons we would not expect the shape of the concentration curves to be the same from one tidal period to the next .

One feature which appears from the figure is the relatively peaked distribution of the more prominent "groups" of oyster larvae. It is this feature of the observed distribution which differs most markedly from the distribution which would be expected from a consideration of the mixing processes.

The principles employed in the development of the salt balance equation may also be employed in describing the time change of any dissolved or suspended material carried by the water. The studies of the salt balance provide means for estimating the effect of the circulation and mixing on the distribution of any other substance partaking freely of the water movements. Oyster larvae, while having the ability to swim, are generally considered to be incapable of anything but random movements. Consequently, we might expect that they could be considered theoretically the same as dissolved material.

The application of the results of our studies of the salt balance to an assumed initial distribution of oyster larvae allows the prediction of the variations in the spacial distribution of the larvae with time. Preliminary results of such application give computed distribution similar in shape to the observed larvae distributions if the age of the larvae is assumed to be two or three tidal cycles.

Dr. Andrews has suggested (personal communication) that the larvae collected were in general two or three days old, or from four to six tidal cycles. The computed distributions after four tidal cycles appear much less sharply peaked and spread over a larger area than the observed larvae distributions.

The discrepancies between the observed and computed distributions of oyster larvae may indicate a failure of the theoretical treatment. However, experiments with dye in large scale models of estuaries indicate that dissolved or suspended material spreads at a considerably faster rate than is suggested by the observed larvae distributions.

Another possibility suggested by the difference between observed and computed larval distributions is that the oyster larvae cannot in fact be considered the same as dissolved material but rather exhibit some ability, independent of the physical character of the circulation and mixing processes, to remain closely grouped. Such a tendency could be the result, for example, of the larvae near the periphery of a particular brood dying at a faster rate than those near the center of the group. The possibility of the oyster larvae having a "swarming" tendency has been suggested previously by oyster biologists.

The study described here illustrates the fact that the physical scientists when attempting to apply physical theories to biological problems, must take into account the possible modifying factors peculiar to the organism involved. Some responsibility must then rest with the biologists to supply information concerning the organism which might modify the influence of the physical factors.

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A Critique of Present Biological Research on Oysters

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Oyster Institute of North America, Annapolis, Maryland

Research on oysters of one variety or another has been carried on in the United States for almost 50 years, and even before 1900 experiments on transplanting oysters were being attempted. It appears that far more research has gone into oysters than any other species of marine animal. However, the results have been used in only limited ways by the industry. Let us stop to consider for a moment the oyster industry as it is now and its condition 50 years ago.

Harden F. Taylor (1951) and his associates showed a drastic decline in production. According to their statistics, 172,885,000 pounds of oyster meats were produced per year during 1889-1892, representing 16.1 per cent of all food fish produced in the United States. By 1908, the catch had declined to 152,040,000 pounds of oyster meats, 9.6 per cent of all food fish, and by 1938-40 the average catch amounted to 89,740,000 pounds, representing 3.1 per cent of all food fish.

The decline has been common to all areas along the Atlantic Coast, but less on the Gulf. Statistics for 1950 indicate the same relative position of the various states and little change in the production. The causes for these fluc-

tuations are most important and could well form the basis for a symposium. However, it is impossible to analyze the factors here.

Biological research on oysters may be divided into a number of headings, including: factors influencing spawning and setting, with attempts to predict time and intensity of the set, studies on control of parasites and enemies, feeding and fattening of oysters, factors determining the productivity of oyster bottoms, breeding experiments and environmental studies. Some of these matters are being studied at five Federal, ten State laboratories, and at least half a dozen universities and private organizations. The writer is not familiar with details of all research being carried on regarding the Eastern oyster on the Atlantic and the Gulf, but most of the projects are being conducted by state and federal laboratories, and fall within one or more of the categories listed above.

Some might wonder about the concern of this paper in biological research, since production has been affected so little in the past. The answer, of course, is that any industry that has steadily lost and is losing ground in production is an industry that needs research desperately. The demand for oysters today far exceeds the supply. The industry must meet this demand with a quality product in sufficient supply. If the industry succeeds in increasing production substantially, a large group of consumers will be available who are already educated to the palatability and the nutritional value of the oyster.

It is the writer's opinion that political considerations, rather than the lack of knowledge, has most frequently been the reasons for the decline in the industry. Individuals in the industry have also resisted, in some cases, the use of new methods. The oyster industry has set up a committee on shellfish research. This group meets with agencies to discuss needs of the industry and the type of research they believe should be carried on. In so far as is practical, those in charge of research projects have been most cooperative, and have in many cases drastically modified their programs to conform more closely with industry needs.

This does not necessarily mean so-called applied research, as will be illustrated. Consider first some of the work being carried on by Dr. Philip Butler at the Pensacola Laboratory of the U. S. Fish and Wildlife Service. Most observers will concede that selective breeding of oysters is far from practical on a commercial basis. And yet the industry has strongly urged the federal agency to continue and expand these studies. They believe that this type of research might well revolutionize the future of the industry. Agriculture, by the use of hybrid strains developed through research, had been able to increase production in the face of lost fertility of soil and ever-dwindling acreages. There are no obvious insurmountable hurdles in this direction with the oyster. The suggestion has been made that this research could be done better in a location other than Florida, particularly in the north, because of more adequate facilities. However, the advantages of rapid growth, and early sexual maturity of oysters in the south, making possible the observations of many generations in a few years, greatly shortens the time necessary to produce results.

Another so-called pure science project being carried on by the Federal government, of which the industry has expressed approval, is the comprehensive study using radioactive tracers of the feeding of oysters and their utilization of nutrients from the food taken. While there is no known practical application of the knowledge that will be gained, it may be invaluable in perfecting culture

techniques to obtain fat oysters high in glycogen, or with other desirable characteristics.

It is estimated that about $250,000 is spent each year on oyster research by the Federal Government and the States. Most federal funds are spent on fundamental problems, with less emphasis on such things as surveys, and other limited projects which yield local results and are more properly in the province of the states. Many states have recognized their needs for shellfish research. Almost every oyster producing state now has a biologist attached to its staff. The only states who have not progressed that far are those where the Federal Government continues to perform local services. The southern states particularly, in the last ten years, have gone a long way to remedy their research deficiencies. A good deal of the credit for this progress has been the result of the activities of the Gulf and Caribbean Fisheries Institute, the Marine Fisheries Commissions, and similar organizations.

The function of the state should be to supply information on which to develop a system of oyster culture within that state. Most states do not have the facilities, money or staff to carry on long term research, which, when completed, could be generally applied. Actually, it is doubtful whether Governors would recommend such expenditures or State Legislatures would approve them By the very nature of things then, we have a diversion of the type of research, which should be carried on by the Federal and State agencies. This is obviously not a rigid rule but appears logical. This does not necessarily mean reduction in the calibre of research. It is possible, and likely, that local ecological studies designed to meet the needs of a given area in a southern state might well prove to have general application over a wide area in the Gulf and South Atlantic. The fact that a problem is being studied in a limited area does not justify careless methods or observations. To be successful in modifying local methods and procedures as an aid to increase production the state scientist must be as precise and as analytical as if he were trying to determine basic principles which would apply everywhere in the industry.

Recently there have been a number of demonstrations of the assistance which can be rendered to a state in its oyster culture program. As a direct result of studies and examinations of the Chesapeake Bay, Mr. G. F. Beaven, Shellfish Biologist, recommended the establishment of a seed area in an area of that Bay which had never been considered valuable as seed grounds. Today, Punch Island Bar, the area in question, is one of the most important seed bottoms in Maryland. The State has increased greatly its supply of seed oysters by using this new area discovered by scientists.

All too frequently in the past, some oyster biologists have been swayed by the political pressures from scientific interpretation of their findings. To yield to such pressures is damaging both to the scientific integrity of the individual researcher and to the entire industry. Political considerations grow few oysters, while sound scientific findings can be the salvation of the industry.

The great need in the south is not to obtain a "set" of small oysters, which is the big problem north of Virginia, but rather to develop oysters that will fatten well, and not be subject to widespread mortalities before they can be harvested. The inevitable argument of the advisability and practicability of tonging versus dredging on public bars is another problem facing both the administrator and scientists alike. Last but not least is the necessity to protect

the oyster from the possible effects of industrial pollutants. The research on selective breeding and effects of environment on characteristics of oysters has already been mentioned. These studies may make it possible to grow oysters which will fatten and be disease-resistant. More desirable characteristics might be developed on beds by introduction of selected strains, which have demonstrated their ability to build up glycogen and resist disease or certain types of pollution.

We must isolate and better understand the factors causing mortalities. The work on *Dermocystidium marinum* has already made us aware that there may be factors at work not known before. The studies dealing with carbohydrates in sea water may also be significant. The tracking down and complete isolation of every factor which might limit or control the size of the population is of the utmost importance. The rapidly expanding industrialization of the southern areas of our country is another fact which should not be overlooked. It is probable that the mortalities which have occurred in recent years have been brought about by a complex of conditions, producing many divergent pressures upon the organisms.

No mention has been made here of the results of much of the research done along the Gulf Coast in the last several years. Most of the publications which have been released have reported findings of only the early part of the investigations. When the final results of these studies are published and careful analysis made of this research, it is possible that the effects of the complex interrelationships of ecological conditions will become clearer. For example, it might be that while *Dermocystidium* infection of a bed of oysters alone would cause serious mortalities, this disease plus some pollutant in the water would be enough to destroy the bed. Conversely, pollution might not be a limiting factor alone, but pollution plus the temporary lack of one essential constituent might be damaging.

There are problems other than these mentioned which should be studied. Oyster pests is one of these. Drills and other marine animals abundant in the south do serious damage in certain areas, and on some instances almost destroy oyster populations. Practical methods of control of these pests should be studied. In the north much study has been devoted to the control of these enemies since they destroy hundreds of thousands of dollars of oysters there each year. Scientists have developed traps and dredges to catch drills, but control is being practiced successfully only in limited areas in the Chincoteague Bay in Virginia and in parts of Long Island Sound. The most successful techniques for control being used were not developed by scientists but by oystermen themselves. These are the suction dredge and rotary screen. Scientists in the south might profitably devote considerable time to control of drills, and certainly those in the industry would be most grateful for any helpful results.

Attracting or repelling drills by chemicals has been under observation by the Milford Laboratory for some time. While certain chemicals appeared promising, the project has been suspended indefinitely because of lack of funds. Any success in this direction would be most helpful to the industry.

Another pest doing millions of dollars of damage is the starfish. Again, considerable study has been given this form, but the old method of mopping up the "stars" is still practiced by most of the growers, even though it is obviously inefficient and outmoded.

There is another matter which is most important to the oyster industry and

which will probably be of more than passing interest to the shellfish biologist of the south. One of the dominant characteristics of southern waters is the long spawning season and the ability of the oysters to seed themselves successfully. This is in sharp contrast to areas along the Atlantic Coast north from Maryland, where oysters grow and fatten well but where setting is limited and may occur on a commercial scale only once in every 5 to 7 years. The northern oystermen are desperately in need of seed. If a suitable strain of oysters could be developed which could be successfully transplanted to the northern areas, a profitable business could be developed in the south producing seed for the north oyster grower. To the complaint that the south would merely be selling seed to the north to have its own oysters sold back to southern consumers later, it should be said that there is little likelihood that the south would suffer materially from such competition, since northern and southern markets are generally different and the oysters from the two areas are handled in a completely different manner. Instead an entirely new, profitable industry would have been created.

Mr. Lunz and Mr. Beaven have reported elsewhere in this journal their experiments in transplanting seed from South Carolina waters. While these experiments have had only limited success, they should be continued, and similar attempts made in other areas.

A complaint which has been directed at state oyster biologists is that studies they are carrying on are of neither a long term nature, nor directed at a specific local problem. It is contended that such research is a luxury which can be catered to only by private institutions, who are not responsible to the public for funds. There would seem to be some justification for this criticism. It is suggested that each oyster biologist examine carefully his own activities and ask himself certain questions: "Have my major efforts been directed at solving a biological problem? Do I appear to be making progress in this direction? Is there any useful application of the conclusions I have reached?" If he can answer in the affirmative he is probably on the right track.

Some of the biological problems of the oyster industry have been listed; there are many others. Most of the oyster problems are so complex with so many ramifications, that it will take the best efforts of all the oyster scientists to solve them.

The industry has never looked more hopefully or earnestly to the scientist than today for assistance and guidance in solving the manifold problems in oyster culture, with which he is faced. The oyster scientist has a great opportunity to demonstrate the value of research, since there is probably no marine species which lends itself so well to field and laboratory investigations.

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Chairman—J. L. McHugh, Director, Virginia Fisheries Laboratory, Gloucester Pt., Va.

A Suggested Reorganization of the Florida Marine Fisheries Laws

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Florida has two big problems confronting it in the field of salt water conservation and these problems must be solved if Florida is to achieve an effective, practical and progressive salt water conservation program. These problems are, first, shortage of money and, second, the deplorable condition of the conservation laws.

The State Board of Conservation is charged with protecting an industry which brings in an estimated $500,000,000 annually, yet the total operational budget of the Board has never exceeded its present $214,000. Although the bulk of the money goes for law enforcement, the Board is woefully weak in that department. A total of 41 conservation agents are expected to patrol and enforce 420 Florida laws on 5,000 miles of coastal and tidal waters. They are expected to do this without the aid of airplanes and without radios. In most cases they are expected to do this job with nothing but a small boat and outboard motor. They are further expected to devote all of their time and energy to this job for an average salary of $165 per month.

To do an adequate enforcement job, Florida should have at least 50 per cent more men who are well trained, well equipped, and who can be paid a salary that would attract qualified men to the job and give them an incentive to give it their best efforts.

The Department needs more equipment. It needs better and faster boats. If there is a state that needs airplanes in the Conservation Department, it is Florida, which has the longest coast line of any state in the Union.

This sin of omission on the part of the people to support the Conservation Department and on the part of the Legislature to appropriate sufficient money to operate it properly, is costing the State of Florida millions of dollars that the salt water fishery resources could produce.

At the present time Florida has a total of 420 laws or regulations affecting salt water conservation. Of these, 170 are general statutes; the remaining 250 laws are either local laws or general laws of local application. When we consider that we have fewer than 20 species of marine seafood animals that are specifically regulated by law and that of the 67 Florida counties only 39 counties are involved directly, it is easy to see the problems with which we are faced, both in interpreting the laws and in trying to enforce them, not to mention the fact that so many of them have nothing in common with established conservation principles. So many local and general laws have been passed through the years that the result has been duplication and contradiction. It is apparent that many laws were passed without knowledge of existing

legislation; some, by implication, repealed portions of old laws but left confusing fragments of their predecessors in full force and effect. The result is that in some counties it is impossible to determine where one law leaves off and the other begins.

Many of these acts are what are called "population" acts. Under this system the act is written into the statutes as a general law but is made to apply only to the county or counties within a given population bracket. The net effect is a "local" law. However, in many cases counties for which the regulation was originally designed have grown out of the specified population bracket and other counties have grown into it. For example, we now frequently find a law providing for a closed season on mullet in a county 60 miles from any salt water, whereas the coastal county for which the law was intended has no regulation at all. This assortment of contradictory, outdated and overlapping statutes leaves fishermen, conservation agents, judges, and even lawyers in a perpetual state of confusion and makes effective enforcement a virtual impossibility.

In proposing a reorganization of the Florida salt water fishery laws, the writer firmly believes that the only way to do an effective job is to start from the ground up and build a conservation code or set of laws and regulations that can be understood, that serve the needs of our state fisheries, based on sound conservation principles. To do this would necessitate a repeal of all our present laws, both general and special. Some of these would, of course, be re-enacted as a part of the new conservation code, but we can no longer hope to straighten out this mess by patchwork.

The Legislature, pursuant to constitutional authority, has created a State Board of Conservation and placed in it certain powers. Among those powers is the authority to make rules and regulations. This rule-making power should be clarified. It is only natural that the Board would be reluctant to make a rule inconsistent with an act of the Legislature, although such act may now appear obsolete or contrary to a newly-arising conservation problem. Time, experience, scientific research and the daily accumulation of conservation and economic problems have taught us that some state agency should be granted sufficient authority to meet these problems as they arise without having to wait for a legislative body to convene every two years. It is in the interest of the conservation of our marine resources to recommend that the Conservation Board should have authority to make the following rules and regulations. *Any such rules and regulations would be submitted to the Legislature at the next succeeding session for aproval or rejection.*

1. Fix the seasons when the taking of any of the fishery resources of the state is lawful or prohibited.
2. Define the areas, places and waters from which the various kinds of fish may be taken.
3. Define and fix the types and sizes of gear that may lawfully be used for each class of fish. Define and fix the times, places and manner in which it shall be lawful or possess or use the fish.
4. Regulate the possession, disposal and sale of all coastal species of fish within the state, whether acquired within or without the state.
5. Regulate the prevention and suppression of water pollution, and all infectious, contagious, dangerous and communicable diseases and pests affecting any coastal fishery resources.

6. Fix limits by sizes, sex, numbers, and amounts of various classes of fish which may be taken, possessed, sold or otherwise disposed of.
7. Regulate the landing of the various types of fish.
8. Promulgate such other rules and regulations as may be necessary to carry out the provisions of this act.
9. Establish and maintain a system of state catch statistics with proper penalties to enforce the collection of such statistics.
10. Have authority to promulgate rules and regulations recommended by the Gulf States Marine Fisheries Commission and the Atlantic States Marine Fisheries Commission, of which Florida is a member. (These commissions have proven invaluable in providing an organized forum for the exchange of ideas and information between the states and the United States Fish and Wildlife Service, so that all states may benefit from the experience of each, as well as to work out cooperative fishery explorations and research work that is so badly needed.
11. Fix standards of quality, sizes and maturity of fish.
12. In general, have authority to permit the taking, capturing, possession, sale, purchase and transportation of salt water products.

The present penalty and confiscation provisions are wholly inadequate nd a complete re-writing is necessary. The powers and duties of the conserva- ion agents should be clearly defined, so that the agents will not only have dequate authority to carry out a proper enforcement job but written so that hey will have no difficulty in understanding them.

A long range comprehensive information and educational program is essen- ial to a worthwhile conservation program. Therefore, it is recommended that he new law provide that such a division be set up in the Conservation Department—to work in close cooperation with the Marine Laboratory of he University of Miami, which has done the fishery research for the state or the last 8 years, in order that all necessary information may be made vailable to the public. Sufficient money to educate the people of Florida on ood conservation principles should be appropriated. It would be the duty of his educational director to be continuously devising new methods and ways f getting this information to the people. It would be fortunate for the future onservation and development of our natural resources if such a course was ot only taught but made a required subject in our public schools.

We need to revise completely the tax structure of the Conservation Depart- ent, since the Supreme Court of Florida held, in the case of Hall v. Cald- ell, 37 Sc. 2d 421, that the license law of this state is ambiguous. In fact, trying to piece the law together it has been found to be so uncertain and definite that it is literally impossible to determine just what the Legislature tended. A tax structure should be devised that will give both government nd industry (meaning both sportsmen and the commercial interests) a ir deal.

At present our conservation agents are the sole collectors of licenses relating the taking and sale of salt water products. Such a system is wholly inade- ate. It means that most of our agents spend most of their time visiting holesale and retail seafood establishments in some areas, whereas, in at least counties of Florida we do not have agents and no one to collect licenses all. It is recommended that some public office in every county, such as e county judge's office or tax collector's office should be designated to sell

licenses and that all peace officers, including sheriffs, constables, as well as conservation agents, should be empowered to collect licenses and make arrests to enforce the license and other conservation laws. This would enable the Department to have officers to enforce the license laws in all counties as well as a local office to issue the licenses. At present they are issued in Tallahassee. In the 28 or more counties without agents, we have many places selling seafood that have never bought a license out of Tallahassee and we have peddlers selling from their trucks with no one in these counties to collect a license from them, although they are supposed to be licensed as wholesalers under the law.

The job of Supervisor of Conservation is a big job, too big for one man to handle with an office force consisting of one secretary, one license clerk and a bookkeeper. It is recommended, to provide a competent force for the Department, that a position of Assistant Supervisor or Administrative Assistant be created, with sufficient salary attached to attract a qualified man for the job. It may be advisable to place such person in charge of law enforcement. This would place some type of direct supervision over the agents, and bring about more effective law enforcement. It is impossible at present for the Supervisor to give proper attention to the agents and to attend to all the other details of this office.

The employment of the Supervisor and all other persons of the Department by only one member of the State Board of Conservation (the Governor), rather than by the Board itself, has long been a controversial matter, and is considered by many to be a major weak spot in our present system. It is pointed out that such an arrangement necessitates the training of a new supervisor every four years. All members of the Board of Conservation are elected by the people of Florida and all members of the Board can succeed themselves in office except the Governor. It is contended that this leaves the Board itself without any effective means of carrying out the obligations placed upon it, and certainly no control over the efficiency or inefficiency of persons employed to represent the Board in the field of conservation. Regardless of whether this man has been a good supervisor or a bad one, he is limited in his service to a four-year period, after which time the State ceases to benefit from the investment it has made in his training and experience. Whether these points are well taken is a matter to be gravely considered by conservationists and by the Legislature. The Board of Conservation is founded on the principle of preserving to all the people their great heritage of fishery resources.

There are many other details to be considered in drafting such major legislation and these cannot be discussed here, but the desire of all the people of Florida is to prepare the best law possible and then to unite to work for its enactment. If the great throng of sportsmen, representatives of commercial interests and conservationists unite for the common cause of improving our conservation system, both in practice and with laws, it is certain that progress will be made and the goal of a reorganization of the fishery laws will be reached.

Distribution of Fishery Resources in Relation to Hydrographic Conditions in North Carolina Estuaries

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North Carolina has a unique shoreline. A sand bar, extending from the northern to the southern boundaries of the state—a distance of about 300 miles—separates the ocean from the largest system of sounds on the east coast of the United States, covering an area of between 2500 and 3000 square miles. These sounds differ widely in size, depth and other hydrographic conditions and therefore vary with respect to the fishery resources. The purpose of this paper is to describe the distribution of the state's fishery resources in relation to hydrographic conditions in the various sounds.

The northernmost sounds, Albemarle and Currituck (see Figure 1.), no longer have direct contact with the ocean as they did 100 or more years ago. Waters flowing down the Roanoke and Chowan Rivers and the numerous short, wide streams draining the surrounding lowlands must pass through Albemarle Sound, thence through Croatan or Roanoke Sound into the northern part of Pamlico Sound before reaching the ocean through Oregon Inlet. These sounds, because of their distance from the source of salt water, remain fresh except under certain conditions of wind and tide, when the eastern portion of Albemarle Sound becomes brackish.

The chief fisheries of this area are those concerned with the anadromous species, the herrings or alewives (*Pomolobus spp.*), striped bass or rockfish, and shad. Pound nets and gill nets are the principal types of gear used. Other species taken include the hickory shad, white perch, carp and catfish. There are no shellfish or shrimp taken commercially in Albemarle and Currituck Sounds.

Croatan and Roanoke Sounds are productive chiefly because of their location with respect to Oregon Inlet and Albemarle Sound. The anadromous fishes entering Oregon Inlet in search of fresh water must pass through one of these two sounds in order to reach the spawning grounds. Important fisheries for these species have naturally developed along this migration route. Inasmuch as the spawning runs take place in the spring, the fisheries are necessarily limited to the spring and early summer. Neither of these sounds produce shrimp. Oysters are found in limited quantities in Roanoke Sound.

Pamlico Sound covers approximately 1700 square miles. Its maximum depth is 24 feet, but because of extensive shoal areas, the average depth is probably less than 15 feet. This large shallow sound, receiving runoff waters from the Neuse and Pamlico Rivers and from Albemarle Sound, and salt water from the ocean through three inlets, offers a wide variety of habitats with respect to physical and chemical conditions. As a result, the fisheries are varied as to time and location.

The finfish, which are free to enter or leave the sound through the inlets as conditions change either to their liking or otherwise, are widely distributed throughout the sound during the spring, summer, and fall. Pamlico Sound provides a nursery area for the young of many species and fisheries for several commercial varieties. The anadromous species must pass through the sound

to reach the spawning grounds in the rivers. Fisheries for these species are concentrated in the northern part of the sound along the migration routes leading to Albemarle Sound. In earlier years, important shad fisheries existed along the south shore of Pamlico Sound and in both the Neuse and Pamlico Rivers but, with the general decline of shad along the Atlantic Coast, these fisheries have been reduced in number and importance.

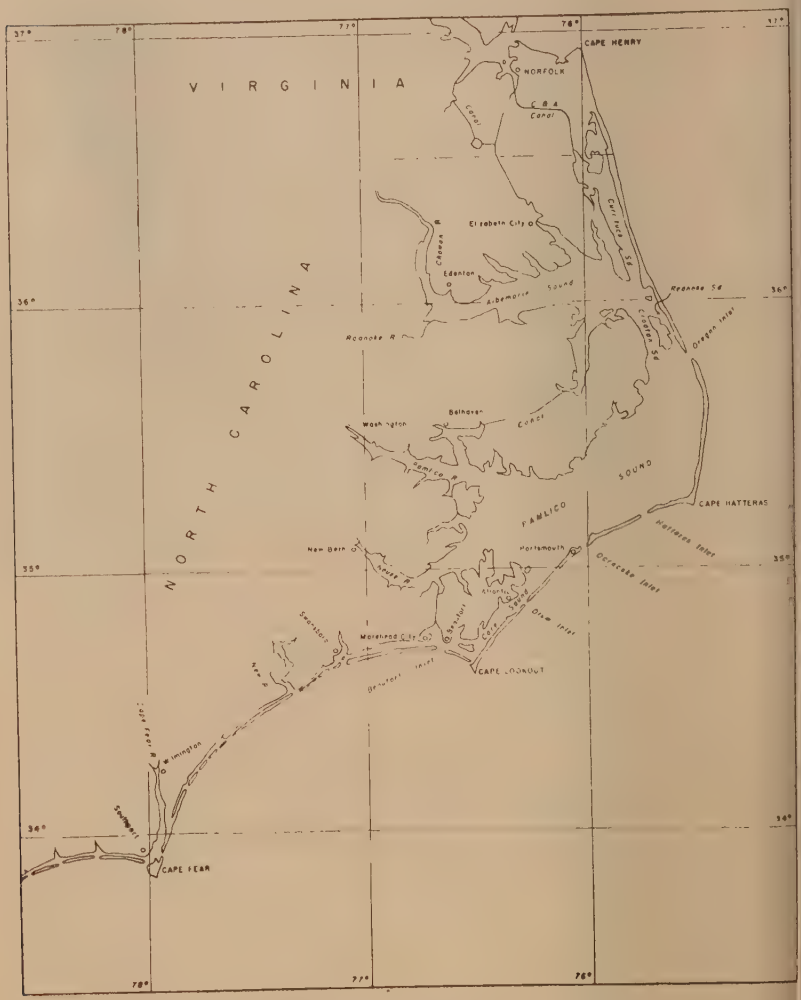

FIGURE 1. Map of the coastal region of North Carolina.

Mullet (*Mugil* spp.) are taken in the western portion of the sound in th bays between the Neuse and Pamlico Rivers. Trout and flounders are foun in various parts of the sound but particularly in the Pamlico River area. Larg

croakers were taken in the sound in earlier years but have not been taken in quantity since about 1930. Their disappearance from Pamlico Sound coincides with an increase in the commercial catch in Chesapeake Bay. Although no data are available, it seems possible that some change in hydrographic conditions in the sounds caused the movement of the adult croaker population. Pamlico Sound contains large numbers of small croakers each summer but the large "jumbo" croakers have not entered the sound for several years.

Movements of fish in and out of the sound are associated with water temperature. During the fall, when water temperatures fall below 10°C., most of the fish move out of the sound and return in the spring when the water temperature reaches 10 to 12°C. The dates when these water temperatures are reached vary from year to year, but as a general rule the sound is barren of fish from December to April, except for the earliest shad which may enter in January or February. A number of trawl hauls have been made during January and February, when the water temperatures were as low as 5.5° to 7.5° and no fish have been taken.

In a hydrographic study of Pamlico Sound, undertaken by the Institute and continued over a four-year period, it has been observed that the water temperature in the open sound follows the air temperature very closely. This is undoubtedly a result of the shallowness of the sound and the almost constant mixing of surface and subsurface waters by the wind. It has also been observed that waters entering the inlets on flood tides during the winter are considerably warmer (4-5°C) than the sound waters. This difference explains why many small fish can be found in the shallow waters off the ocean beach during the winter and not inside the sounds.

The distribution of shellfish in Pamlico Sound seems more closely associated with salinity than with temperature. Oysters, for example, are found most abundantly along the western and northwestern shores of the sound, the areas having the lowest salinities (ranging from 6.0 to 20.8 parts per thousand). Some oysters are found along the eastern shore where salinities range from 10.5 to 30.9 but these oyster rocks are not extensive. There are, of course, factors other than salinity which determine the location of productive oyster beds. There are, perhaps, few places in Pamlico Sound in which the salinity is unsuitable for oyster growth, but in the entire open portion of the sound the nature of the bottom is believed to be a limiting factor. Much of the bottom is soft mud, the rest is sand. But because of the shallowness of the water and the location of the long axis of the sound in the direction of the prevailing winds, the bottom is unstable and, even though oyster beds are formed in this area, their continued success can not be assured. Some small oyster beds have been maintained for a period of years in close proximity to some of the larger and relatively stable shoals.

In the vicinity of the three inlets the salinity is high and less variable than in the sound proper. Here clams and bay scallops are found. Clams are marketed from Ocracoke Inlet, but those from the other inlets are less plentiful and generally serve only to supply the small communities on the outer banks.

The Pamlico Sound shrimp fishery is well known for its economic importance to the state (about one-half of the State's production comes from Pamlico Sound and its tributaries). But there is as yet no evidence linking the distribu-

tion and movements of shrimp with specific hydrographic conditions. There are three species of commercial shrimp in the Pamlico Sound area: the brown spotted shrimp, *Penaeus duorarum*; the brown shrimp, *P. aztecus*; and the white shrimp, *P. setiferus*. The fisheries take adult shrimp, i.e. individuals which are sexually mature or nearing maturity, and which are enroute to the ocean waters, presumably for spawning. Seasonally, the spotted shrimp appear first, usually in May and June; the brown shrimp moves through the sounds in July and August; and the white shrimp follows in September and October. These migrations, occuring over a six to seven month period do not seem to be associated with hydrographic conditions but rather with the development cycle peculiar to each species.

There are also differences in the distribution of the species. The brown spotted shrimp occurs only in the extreme southern portion of Pamlico Sound (it is much more abundant in Core Sound which contains waters of higher salinity) whereas the other two species are distributed quite generally throughout the sound. We do not know enough about the distribution of the larval stages of the three species to know whether this distribution of the adults represents a "preference" for higher salinities on the part of the brown spotted shrimp, or whether the distribution of larval forms might determine the adult distribution. Research along this line is in progress.

Blue crabs are abundant in Pamlico Sound throughout most of the year although there is little commercial production during the winter months. The bulk of blue crab production occurs in the western part of the sound, the low salinity areas, but this is undoubtedly due to the fact that the only markets for crabs are located there. There is only a limited demand for blue crabs and the western area of the sound is able to supply that demand. No special studies of blue crabs have been made in North Carolina, but observations by the Institute personnel indicate that there is a large supply of crabs throughout the sound. Pearson (1951) points out the inverse relationship between North Carolina production and Chesapeake Bay production, and further states that this relationship exists because of economic rather than biological reasons. There is no doubt that the blue crab fishery in Pamlico Sound could be increased several-fold if the demand warranted such an increase.

Core Sound contains water of higher salinity than Pamlico Sound (19.0 - 35.8 p.p.t.), and the higher salinity is reflected by the fisheries. Clams are quite generally distributed throughout the sound and provide a valuable fishery. Bay scallops, which suffered a serious decline in the early 1930's as they did along the entire east coast, have made a comeback during the last few years. Long haul seines are used in the sound for taking a variety of finfish.

There is an important and unique shrimp fishery in Core Sound. The spotted shrimp is the principal species involved. This species is active during the hours of darkness and can be taken in commercial quantities only at that time. This characteristic habit of the spotted shrimp was unknown until 1949, and since that time the North Carolina laws, which previously prohibited night shrimping, have been changed so that this shrimp could be utilized by the industry.

An interesting change took place in the Core Sound fisheries following the reopening of Drum Inlet by a storm in 1933. Prior to that time there were extensive oyster beds in the Sound, particularly in the northern end. After the opening of Drum Inlet and the resultant increase in salinity in northern Core

Sound, oysters decreased in abundance and the clams extended their range to include the northern part of the sound.

Perhaps the best example of the relationship between hydrographic conditions and distributions of fishery resources is the growth of Core Sound scallops in relation to distance from the inlet. Gutsell (1930) pointed out such a relationship by showing that scallops grew faster and larger near Beaufort Inlet than in Core Sound and western Bogue Sound. Scallops are not found at present in many of the areas which Gutsell studied, but are found principally in Core Sound. Barden Inlet, at the extreme southern end of Core Sound (see Figure 1), has developed since Gutsell's study and is responsible for higher salinities in that area than existed prior to the formation of the inlet. Fahy and Chestnut of the University of North Carolina Institute of Fisheries Research (unpublished manuscript) report a progressive diminution in growth rate and size of scallops with distance from the inlet. It is not known whether the differential size and growth rate is the result of the effect of salinity or currents, both of which decrease with distance from the inlet. Gutsell (op.cit.) advanced the hypothesis that currents had the greater influence because of their transport of food and oxygen into the area, and of products of metabolism and decay away from the area. This hypothesis however has not been proved.

Temperature is also an important factor in scallop survival. Fahy and Chestnut report a high mortality in an otherwise successful year class following the extremely high temperatures of June and July, 1952. They observed further that scallops in those areas of deeper water near the inlet, where cooler ocean waters periodically moved in, suffered less mortality than those in the very shallow flats some distance from the inlet.

The exact way in which the various hydrographic conditions (salinity, currents, and temperature) effect scallop growth, size and survival is not known, but it is evident that these conditions act directly or indirectly to limit the scallop range and cause the differences of size and growth within that range.

The remaining sounds, Bogue, Stump, Topsail, Middle, Masonboro, and Myrtle, are small and relatively unimportant in the over-all fisheries picture. There are numerous small inlets in this southern area causing relatively high salinities except in the areas supplied with fresh water from the streams. Clams, oysters, scallops and shrimp are taken in various localities, and these small fisheries provide at least part of the livelihood of the small communities bordering the sounds.

From the above discussion it will be noted that the North Carolina sounds provide a variety of hydrographic conditions and a variety of fishery resources. Some of these are intimately related to specific hydrographic conditions whereas others tolerating a wide range of conditions, show a lesser relationship.

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Computed Ocean Currents in the Gulf of Mexico

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Abstract

A program was initiated at Texas A. & M. College in June 1950 under the sponsorship of the Office of Naval Research for a study of the physical oceanography of the Gulf of Mexico. To date most of this study has been conducted from the U. S. Fish and Wildlife Service vessel *Alaska* with the cooperation of the Service. Several technical reports including reviews of the physical oceanographic and meteorological literature of the Gulf, temperature and salinity distribution studies, and current patterns have been distributed. The most interesting feature described to date is an ocean current in the Gulf which it is proposed be called a fourth major part of the Gulf Stream System.

Proposed New Regulations for the Northwest Florida Mullet Fishery

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The present laws and regulations governing the fishery for black or striped mullet (*Mugil cephalus*) in Florida are numerous, contradictory and, in many cases, badly designed. Frequently they are not enforced, partly because of their poor construction and partly because both fishermen and enforcement officers believe they are not based upon the actual facts. Mullet regulations have been produced largely by rule of thumb. General laws have been so altered by individual county "local" laws that the result is an inconsistent patchwork with several different size limits prevailing along the coast.

Because of its first rank among the fin fisheries of Florida, the mullet fishery has received a major portion of the research carried out for the State Board of Conservation by the Marine Laboratory of the University of Miami. A thorough investigation of such a fishery, extending over a coastline the length of Florida's, requires a long time. The work is by no means finished, in fact only northwest Florida (from St. Marks to Pensacola) has been thoroughly investigated, and that only for one full year. Suggested regulations, therefore, are largely for that region, and these proposals may be changed if further research shows this to be necessary. Despite the inability to propose permanent regulations for the whole coast, it is felt that enough information is available to permit considerable improvement in the present laws, changes which, it is hoped, will increase the value of the catch to the industry.

One basic principle guides the management program proposed for the mullet. This principle is that regulations must be for the benefit of the fishermen. It might be possible to propose ideal regulations which, if enforced, could result in considerable improvements in the size of the mullet stocks, but which might so reduce catches for a period that fishermen could not make a living. To cripple the industry while the fishery was being restored would be bad management. Certainly any regulations which are to be effective in the mullet fishery will, at first, result in smaller catches, *although not necessarily of less value*, in order that stabilization at a higher level of production can follow.

later years, but it is essential that complete disruption of the fishery is not permitted to take place while the adjustments are being made. A further principle followed in this program is that where irreconcilable conflicts of interests exist, the regulations must be designed to favor the largest segment of the fishery.

Present Regulations

At present, regulations on the mullet fishery vary from county to county. In all coastal counties of west Florida west of Jefferson County the minimum size limit of fish is 8 inches and the minimum stretched mesh size is 2 inches. In other Florida coastal counties the minimum size of fish varies from 8 inches to 12 inches. The legal minimum mesh size is 3 inches, but the regulation is largely ignored. The closed season is from December 10 to January 20 in all coast counties.

Proposed Regulations

The proposed regulations include consideration of size limits of the fish, mesh size limits and closed seasons.

Size Limits

a. From the Alabama border to the Jefferson-Taylor County line the minimum legal size limit should be 10" from the tip of the snout to the fork of the tail.

b. From the Jefferson County-Taylor County line south, and including all other coastal counties of Florida, the minimum legal size should be 10½".

Mesh Sizes

a. From the Alabama border to the Jefferson County-Taylor County line the minimum stretched mesh should be 2⅝", when wet.

b. For the remaining coastal counties of Florida the minimum stretched mesh size should be 3", when wet.

Closed Season

The closed season should be abolished.

Proposed regulations are separated into two parts: (1) for northwest Florida, om Jefferson County west; and (2) for the remainder of the coastal area. Considering the second region first, regulations suggested are not different om those now in existence, except that present inconsistencies are eliminated far as possible and the same regulations are proposed for the whole region.

For this region, a minimum size limit of 10½" is proposed, along with a minimum stretched mesh.

It is emphasized that the proposals for this area, which includes most of the ullet fishing grounds of the state, are temporary only and may be altered ter the research which is now in progress is complete.

In the northwest area the proposed regulations suggest an increase in minium size limits from the present 8" to 10" and an increase in minimum esh size from the present 2" to 2⅝". It is proposed that closed seasons abolished.

Discussion

The technical information which has served as a basis for these proposals s been published, in part, in the various Quarterly Reports on Fisheries search, issued by the Marine Laboratory of the University of Miami to the lorida State Board of Conservation. The reader is referred to reports by yll and Sutton (1952) and Broadhead (1953) for more detailed data.

It has long been the contention of fishermen in west Florida that the mullet in that region were of a separate population from those farther east and south, and that these mullet were of a smaller average size than those in other areas. If this were true, it would justify small legal size limits in west Florida.

Extensive sampling and tagging upholds the view that there are more than one population of mullet in Florida. The evidence is the following:

1. Tagging has shown that most mullet appear to remain in the same general area for considerable periods. Most fish have been recovered within 20 miles or less of the place where they were tagged. This includes fish free from 9 to 12 months and fish at large over a spawning season.
2. The average size mullet caught is progressively smaller toward the western part of the state.
3. The time of spawning is different for different areas, becoming progressively earlier to the westward.
4. The average size at maturity is different for different areas, becoming ing progressively smaller to the westward.

In other fisheries minimum size limits for fish have frequently been set to allow the fish to spawn at least once before being subjected to capture. There is, of course, justification for this, particularly in an intense fishery, or in a fishery for a species producing few eggs, where there is danger of insufficient spawn to maintain the stock. A more precise method of setting minimum size limits depends upon the relationship between growth rate, natural mortality rates and fishing rates. With fish which grow slowly after reaching marketable size, and which suffer a high natural mortality, a larger total yield can be obtained by catching the fish at a relatively small size. The size at which the largest yield can be obtained may actually be smaller than the size at first maturity, in extreme cases. Conversely, with fish which grow rapidly after reaching marketable size and which have a low rate of natural death, a greater yield may be obtained by delaying capture until the fish are of a comparatively large size. A further factor enters into the consideration of the optimum size limit; namely, the comparative market prices of large and small fish. Weight of fish increases about three times as fast as length, and it is often much more profitable to delay capture of fish until they are of a larger size, since the unit price then increases. This is the case with the mullet. The size limits suggested here for the mullet in northwest Florida are based on the growth and mortality rates, and on the price differential between large and small fish. Growth rate and mortality rate data are incomplete and some error may have been resulted from this but it is thought that this should not be large.

Wholesale dealers in northwest Florida agree that the quantities of small mullet (under 10 inches) placed on the market from time to time are the biggest factor in keeping the price at a low level. These small fish are often sold for one-third to one-half the price of the larger mullet. When fish are plentiful, truckers, upon whom many wholesale dealers depend to sell the fish, will not pay the higher price for the large fish. Wholesale dealers are then forced to cut their prices on larger fish to avoid spoilage. These price cuts are passed along to the fisherman.

Price cutting is also encouraged by the lax enforcement of licensing law

Many fishermen and retail dealers act in the capacity of wholesalers and do not have wholesale licenses. They can operate with less expense on this basis and provide unfair competition to licensed dealers. Prices are consequently lowered and all concerned suffer.

A proper harvesting of the present supply of mullet could increase its value to the fisherman greatly. Table 1 shows the theoretical increase in poundage and value of the catch which should result from the imposition of the minimum sizes proposed. These figures ignore possible improvement in the stocks of fish from the increased spawning.

It is expected that the strict adherence to the new size limits should increase the landings of mullet after initial decreases in production. An even larger increase in total income to the fishery should result from the larger average size of the fish.

Mesh Size

A combination of both minimum fish size and mesh size limits are necessary to insure that the proper size of fish are caught. The minimum mesh sizes are set as a result of measurements of fish from various-sized meshes. A range of sizes of mullet are caught by any given size mesh, and the mesh sizes suggested, will, of course, catch some smaller fish than the legal minimum. Allowance should be made in the wording of the law for those few smaller-than-legal fish which will be caught by the legal mesh nets.

The mesh sizes proposed should apply to gill nets, trammel nets and beach seines. One of the most difficult decisions to make in drafting these proposals was whether to permit a smaller mesh size for beach seines, either for the whole net or for the bag only. It is poor management practice to penalize a fishing gear merely because it is more efficient, as the seines are. In this case, however, there is more than efficiency involved, since the seines with small meshes catch small fish in west Florida; and the whole management program would be endangered by allowing one gear to catch mullet smaller than the proposed minimum. Initially the production from seines would fall as a result of these regulations, but if the population increases in numbers and average size, as it is expected to do, the seine fishermen would ultimately benefit along with the rest of the fishery. The apparent present downward trend in abundance must be checked some time and the sooner the better. It is not thought desirable nor necessary to permit a smaller mesh size in the bags of the seines, since this too would permit the capture of under-sized fish.

It is true that some small fish would gill in the net if the meshes are large. This constitutes a nuisance to seine fishermen, but it cannot be allowed to endanger the whole management program. The size of fish in a school can be roughly estimated by experienced fishermen, and many schools of small mullet which are now set on would be avoided if the fisherman knew he could not legally catch or sell the fish.

TABLE 1

THE RESULTING CATCH OF MULLET AND ITS VALUE, USING VARIOUS MINIMUM SIZES—TOTAL POUNDAGE IS THAT WHICH WOULD THEORETICALLY BE HARVESTED FROM EACH 100 POUNDS OF FISH ENTERING THE FISHERY; VALUE WAS CALCULATED USING 3 CENTS PER POUND FOR FISH 9⅞" AND BELOW, AND 10 CENTS PER POUND FOR FISH OVER THIS LENGTH.

Minimum Size Imposed	Catch in Pounds	Value
7⅞ inches	147.0	$10.92
7¾ inches	152.8	12.01
9¼ inches	154.8	13.02
9⅞ inches	155.3	14.16
10½ inches	153.5	15.35
11 inches	150.4	15.04
11½ inches	143.5	14.35
12¼ inches	136.4	13.64

Fishermen have a large investment in nets of smaller mesh size than those proposed here. To avoid the loss which would result in outlawing these nets abruptly, it is proposed that the regulations should not go into effect until one year from the time the law becomes effective. This will allow the fishermen to wear out the old nets.

Closed Seasons

It is proposed that closed seasons be abolished in the mullet fishery in Florida. This may seem to be a revolutionary proposal, but it is believed to be based on adequate reasoning.

Closed seasons are imposed for the following reasons:

1. To reduce the fishing effort.
2. To protect ripe females and thus ensure adequate spawning.
3. To prevent the capture of fish in poor condition.

The reduction of fishing effort cannot be accomplished with any precision by closed seasons. As Herrington (1944) points out: "... the effectiveness of a reduction of 20 per cent in the season's length, in an effort to obtain a 20 per cent reduction in the catch, would depend on the time of the year included and might easily be rendered ineffective if the fishermen worked a little harder during the open season." A closed season would be justified if it were imposed during a period when, by reason of their schooling behavior the fish were more than ordinarily vulnerable to capture, and the fishing gear could take a dangerously large portion of the run. On the other hand, if capture of the fish were easier during this period, it would be improper to penalize efficient fishing, and force fishermen to make their catches during periods when the schools are more scattered and difficult to intercept. The method which allows the permissible quantity of fish to be caught with the least expenditure of man-hours and energy is the best method. In the case of the northwest Florida mullet fishery, it is thought that fishing effort will be controlled sufficiently by the size limits suggested, without the additional penalties of closed seasons.

It is traditional among fishermen and others to believe that fish, particularly female fish, require special protection when they are in spawning condition. This is justified when there is reason to believe that depletion, if

exists, is caused by insufficient egg production. This may be the case in some fisheries, but it is considered by fishery scientists that scarcity is usually caused by other factors and that the egg potential of a relatively small population is sufficient to maintain the stock. Protection of a certain segment of the spawning population is certainly essential, but this can be better accomplished by size limits than by closed seasons. Female fish caught a month before the spawning season are as surely lost as reproducing units as those caught during the spawning season.

In cases where fish are in poor condition during the spawning period and are thus of less value in the market, they should be protected from capture. In the case of the mullet, however, the female fish are of considerably greater value when they are in full roe, since the roe brings a high price. To prevent the capture of these fish would greatly reduce the value of the fishery.

At present the closed period is fixed in west Florida at a time when little fishing is done, because of scarcity of mullet. It does not serve to protect spawners. The success of these proposals as a whole depends on rigid enforcement. Other states are able to do the job, and Florida must do so as well. This argument in favor of abolishment of the closed season on mullet now does not mean that a closed season may not be desirable at another time, or, more important, for other species in Florida. Inability to regulate other fisheries by size limits might easily leave no alternative than to suggest closed seasons for other fish as a means of reducing fishing effort. Furthermore, new information, or changed conditions, may necessitate re-imposition of closed seasons on mullet at some future time.

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Review of the Caribbean Fisheries Conference Held in Trinidad in March, 1952

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Some background of the Caribbean Fisheries Conference that was held in Trinidad during March of 1952 can be obtained from the foreword of the Report. "The Caribbean Commission and its predecessor, the Anglo-American Caribbean Commission, have always given prominence to the subject of fisheries. The Anglo-American Caribbean Commission included fisheries in the agenda of the West Indian Conference (First Session), held in Barbados in March 1944; the Caribbean Commission included fisheries in the three fields selected for emphasis at its Thirteenth Meeting, held in St. Croix in November 1951.

"A Caribbean Fisheries Conference was recommended by the Caribbean Research Council in 1950. Owing to financial considerations, and to the time required for its preparation, the conference was not convened before March, 1952. The attendance of representatives of the territories of the four

National Sections of the Commission, the United States of America and the United Kingdom, and by observers from the territories and from the Food and Agriculture Organization of the United Nations, the Marine Laboratory of the University of Miami, and the Government of Canada, testifies to the importance attached to this subject in the Caribbean area."

Following on the recommendation of the Caribbean Research Council at its third meeting in June 1950, that a Fisheries Conference should be held, the Commission accepted this recommendation, but subsequently found itself unable to make provisions for the conference in its 1951 budget. The Research Committee in Agriculture, Fish, Wildlife and Forestry of the Research Council urged the Commission at its meeting in April 1951 to reconsider its decision, and convene a Fisheries Conference before the end of 1951, considering "That the time is ripe to hold such a conference owing to the presence of a number of marine biologists, and fishery specialists, and the great need for assisting junior fishery personnel in the area."

The Commission accepted this recommendation and a Preparatory Committee was convened in July 1951 to prepare the agenda for the conference, which the Committee recommended should be held in March 1952.

In planning the agenda, the Preparatory Committee, of which the writer was a member, felt that many reports had been written from time to time on the several fisheries of the Caribbean, but unless one was really fortunate enough to have all the reports at his disposal, it would be quite likely that some important point might well be missed.

However after circulating Governments for information, additions to the agenda prepared by the Preparatory Committee were proposed by the Caribbean Research Council, the Caribbean Commission, the Government of British Guiana, the Government of Barbados and the Secretariat, and the final agenda for the conference covered the following subjects:—

1. Occurrence and distribution of commercial fish species in the Caribbean, including lobsters, shrimps, oyster, sea urchins, etc.
2. Techniques practiced in the Caribbean for fish capture.
3. Types of fishing craft in use in the Caribbean.
4. Marketing, including storage and distribution.
5. Methods used for conserving and processing fish in the Caribbean.
6. Cultivation of fish in ponds.
7. Application of recent technical knowledge to exploration and development of new fisheries.
8. General matters:
   (a) Recommendations of the West Indian Conference, First Session 1944:
      (i) Designation of Fishery Experiment Station at Mayaguez, Puerto Rico, as the center for technological research and information services in the Caribbean, and for biological research relevant to its own area.
      (ii) Establishment of a Fishery Research Institute in the British West Indies.
      (iii) Importation of fishing gear on the same terms in respect of customs duties as agricultural equipment.

(iv) Application and extension of co-operative principles to the fisheries with regard to marketing, credit and savings, purchase of gear, and insurance.

(v) Provision of educational facilities to fishermen.

(vi) Appointment and training of fishery officers.

(b) Preparation and collection of fisheries statistics.

(c) Recommendation of the Industrial Development Conference regarding fish processing.

(d) Relations with FAO Fisheries Council for Latin America.

(e) Proposal of the Government of British Guiana regarding central measures or close seasons in respect of fishing in Caribbean territorial waters.

From the foregoing agenda, it will be realized what an ambitious effort this was, but it was felt that every opportunity should be taken to bring these matters to the attention of the territorial governments.

A collection of documents were submitted by fishery personnel attached to several Government Organizations dealing with the following phases of fishery development:—"Blackfish Hunting off St. Vincent" was presented by R. S. Rack, Fishery Adviser to the Windward Islands. "The Application of Recent Technical Knowledge to Exploration and Development of New Fisheries" was submitted by Richard T. Whitcleather. "Experience of the Government of Puerto Rico in the Development of the Commercial Fishing Industry" was presented by Luis C. Bonnet. "The Lobster Industry of British Honduras", was presented by Evan P. Bradley, Fishery Officer. "The Distribution of Fish Species in the French West Indies", by Dr. Merice and Dr. Cadenat. "Fish Culture in Brackish Water Ponds" was presented by E. J. Reijntjes. "The Work and Proposed Programme of the Department of Agriculture of British Guiana" was presented by W. H. Allsepp, Fishery Officer. "Flying Fish Research in Barbados" was reported on by the writer as well as the Government's assistance in the fishing industry of Barbados.

Many of these papers cover a wide field of development in their respective territories over the last six to ten years and any one interested in Caribbean development is urged to write the Central Secretariat of the Caribbean Commission and request a copy of the report "Fisheries in the Caribbean", as all of these papers form an appendix of the general report.

A very useful discussion took place on "The Establishment of a Fisheries Research Institute in the British West Indies." We were fortunate to have that discussion led by Dr. Walton Smith, Director of the Marine Laboratory of the University of Miami, and Richard T. Whitcleather, of the Fish and Wildlife Service. At the conclusion of these discussions it was resolved that the Caribbean Commission should be asked to sound out all Governments and other organizations from which financial assistance could be brought to bear on this important matter. Fishery men in the Caribbean area are still hoping that this initial effort in bringing the need of research to the notice of Government and organizations will meet with the success it deserves.

Problems of the Commercial Fishing Industry

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It would appear from the papers presented at the Commercial Fisheries Session, and from the subsequent discussion, that three major problems are uppermost in the minds of those connected with the commercial fishing industry. These problems are *quality*, *new markets* and *imports*. These three subjects came up repeatedly throughout the session, and fishermen, wholesalers, brokers and scientists alike made frequent reference to them.

The need for improved quality of fishery products appeared to be uppermost in the minds of most of those who engaged in the discussion. A general belief prevailed that a satisfactory solution to the other two problems—expanded markets and foreign imports—depends upon improvement of quality.

In the menhaden industry there is concern over dwindling markets for oil. An unprecedented worldwide surplus of fats and oils has aggravated the difficulties which the menhaden industry has been experiencing in maintaining markets for oil. The declining market for this product has been increasingly serious ever since detergents began to replace soaps. Suggestions that fish oils might be used as supplements in both human and poultry and stock feeds brought the reaction that such oil would have to be of high quality. The possibility was expressed that fish oils would give poultry and stock flesh undesirable flavors. This does not happen, it was stated, if the oil used is from good quality raw product and is carefully processed so as not to include unsaturated oils. Fish oil producers must find a new large volume outlet for their product, and new uses which absorb only small quantities will not solve present difficulties.

The question arose as to whether "whole meal" might not prove superior to the fish meal now produced. It was stated that Norwegian producers had found that some markets were willing to pay premium prices for whole meal. This was not a universal experience.

The plight of the small menhaden producer was discussed, and it was agreed that he can survive only if his plant can find some way of operating the year round. Here the question of imports was brought up, and some speakers thought this would be one way to insure an all-year supply of raw product. Another possible source of raw material in the off season, to supplement the menhaden supply, is "scrap" fish and shrimp waste. It was pointed out that the problem of collecting this material is the biggest difficulty. So far no satisfactory solution has been found.

Quality, increased markets and imports appear to be inseparately associated in the shrimp industry. Concern was expressed about the large and increasing volume of imports of shrimp into the United States, principally from Mexico. Some speakers suggested that imports be restricted to those foreign producers who could show that wages and living standards generally of those

engaged in the industry were comparable to American wages an living standards. The practical difficulties of dictating standards to another country, and more basic than that, of determining what are comparable standards, seemed to other observers to invalidate this approach.

Many of those present thought the solution lay in expanded markets. These would depend in large part on improved quality. How to achieve this improvement was also the subject of debate. The general consensus appeared to be that quality improvements could only be achieved through standards established by the industry itself and maintained by inspection by a government agency, preferably the Fish and Wildlife Service.

Trends in Exploratory Fishing and Technological Research

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In the discussion of the paper by Louis S. Mowbray, it was brought out that the Larson trawl in its present form may be utilized only by two boats. Because of its size, it cannot be handled by a single boat, but it may be used as a bottom trawl. The government of Bermuda plans to continue studies on fishery problems, even though the current studies discussed failed to disclose the presence of fish, since gill nets were set with the wind and in the wrong tide. There is no demand for natural vitamin A from a shark fishery since synthetic vitamin A is very cheap and recent experiments show that there is no difference between the synthetic and natural products. There may however be a market in the future for shark meat as there is now in Bermuda where it is considered a delicacy when fried or boiled and heavily seasoned. It has been used in other countries when sold as "swordfish" and canned as "grayfish." Both yellow-fin and black-fin tuna occur to some extent in Bermuda waters. There does not seem to be too good a possibility of there being sufficient raw material to support a fishery. They do not enter the local fisheries, and are only taken while trolling. There is a greater prevalence of yellow-fin tuna when the waters are at 70° F. Apparently their range is between 57° and 84° F. Black-fin tuna are present all year. In the summer months when the water temperature approximately 80° F. the yellow-fin tuna are deep and the black-fin tuna are on the surface. While large amounts of bait-fish are present, there have been no appearances of menhaden-like fishes reported. There is a thermal layer in the water surrounding Bermuda where plankton seem to concentrate and while shrimp may have been present there are no pelagic fish.

Following the paper by C. B. Carlson, it was learned that, although TV gear was not utilized as had been hoped, television has a practical application, i.e. to note stress and strains on the nets and the way in which the nets are working rather than to view the shrimp actually entering the nets. The camera has a range of 200 feet in very clear water, but may not be used in turbid water. Experiments with a mud rope showed no handling difficulties at 35 fathoms, but at greater depths such as 250 to 300 fathoms, the mud rope was difficult to handle and it was necessary to substitute a chain breaker line.

According to Mr. Stewart Springer: The Gulf tuna boats are mainly using harengula for bait. Ground chum and other dead fish have been tried, but

live shrimp have not. Long line fishing was attempted consisting of a long floating main line, with smaller lines with hooks running off therefrom. Black-fin and white skipjack schools were found to be mixed. The black-fin were seen more readily. The weather cycles in the Gulf are good in summer, bad in winter, the hurricane season in the fall, although the southern Caribbean is free from hurricanes. Some months are better than others; tuna boats cannot afford to return to shore because of weather.

Virgil E. Harris, in the discussion, stated that Professor McMillan in electrical fishing, in 1928 used frequencies higher than 60 cycles; his experiments were made with frequencies up to 500,000 cycles. Effective range does not seem to allow for practical fishing since distances are only about ten meters. It is probable that differing current densities will be necessary in order to induce electrotaxis in different species of fish. Rough fish were cleared from inland waters in Germany, in fresh water; therefore heavy amounts of current were needed. A new adaptation of electrical fishing has been use of a double-hook line which forms an electrical field to stun the fish. This has primarily been used for tuna and a company has produced approximately thirty sets of the gear. By utilization of this gear the fish is stunned so that it lies dormant and may be handled with greater ease.

Higman & Idyll stated that the objectionable odor noted in shrimp held in sea water, after approximately eighteen days, was a strong shrimpy odor, earthy and musty. There was no odor of hydrogen sulfide and both heads-off and heads-on shrimp exhibited identical odors. The experimental work was done in an attempt to produce an easy and cheap method for refrigerating shrimp where fishermen cannot afford to purchase freezer boats or install freezers on their present boats. Temperature is the key to success in holding in sea water, and although experiments showed that shrimp were of an acceptable quality when held for 24 days, the authors do not recommend that they be held for such a period of time. There is no apparent softening of a shrimp when held in sea water brine at temperatures from 29 to 32° F. There is, however, a very definite protein loss by leaching; and the refrigerated sea water tends to toughen the shrimp when compared to shrimp held in ice. The authors feel that while they have always recommended quick freezing as the best method of preserving shrimp, where it is impractical or impossible to utilize such a method,holding in refrigerated sea water is far superior to utilizing the conventional icing methods on shrimp. So far as is known no experiments have been conducted on the freezing of shrimp after holding in refrigerated sea water.

The major portion of the discussion on the paper by Earle L. Divers was on glazing of shrimp. It was brought out that utilization of a brine glaze causes the shrimp to be too salty and also the salt seems to concentrate in spots on shrimp, which breaks the glaze and the shrimp subsequently become black-spotted, not in any given area as true melanosis but in minute spots approximating the size of a pinhead all over the shell. Spray glazing is difficult and is the poorest method of any in use, since it does not coat all of the shrimp in the package. The author has found shrimp which were rancid to taste, although it was brought out that shrimp contained an exceedingly low percentage of fat. It is felt that the occurrence of rancidity in shrimp is exceedingly rare. Packaging of shrimp in large cans may be possible although it was felt that the utilization of such package material might after a considerable length

of time produce a somewhat dehydrated product. Observations after several months of shrimp frozen in cans, showed no dehydration. The author did not feel that utilization of deveining machines would alter prices to the consumer.

The Emphasis in Oyster Research in Past Years

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Eight papers were presented to the morning session of the shellfisheries session of the Institute. This meeting was guided by Chairman William W. Anderson of the Fish and Wildlife Service. Summaries of the papers by the authors (with two exceptions) were presented in the abstracts section. Discussion was deferred until the afternoon panel session, when the papers were examined in considerable detail. It should be noted that there were two substitutions for authors in presentations of the morning session. First, Mr. George Gehres presented the paper by Richard P. Hardison which discussed bacteriological standards for oysters under conditions of a semi-tropical climate. Second, Chairman Anderson presented the paper by Phillip A. Butler which contained data on the importance of local environment in control of growth in oysters. Otherwise all papers were presented by the authors.

In the absence of A. E. Hopkins of the Gulf Research Laboratory of Mississippi, Dr. Paul Galtsoff consented to serve on the afternoon discussion panel. With Mr. J. N. McConnell of Louisiana and the authors of the various papers completing the panel.

Papers were discussed in the order in which they were read, with the exception of the first. Mr. Gehres was detained but since the contents of Mr. Hardisons' paper is of very considerable importance to the oyster industry some remarks concerning certain portions of it may not be amiss.

The paper did not attempt to present research data, but raised certain questions concerning the applicability of bacteriological standards developed for a more northern climate, to the semi-tropical Caribbean and Gulf coasts. Among other points made it was suggested that studies be made on several phases of the problem. These were (1) effect of temperature on the death rate of coliforms, (2) the effect of salinity on death rates under subtropical conditions, (3) determine whether or not development of coliforms takes place in oysters, and (4) studies to determine whether or not obsolete methods are being used. It is clear that such studies must be of primary importance, due to the fact that health agencies are bound by law to close to oystering those areas not meeting standards as now set up. If, as suggested, the standards themselves do not fit the climate, or have become obsolete, the oyster industry may be taking unnecessary penalties under the closure laws.

Philip A. Butler, Director of the Pensacola, Florida Station described in his paper, which was presented by William H. Anderson, difference in mortality and growth in oysters placed on opposite sides of the island on which the Pensacola Station stands. These stations were substantially equal as regards such factors as salinity, temperature, depth, turbidity, etc. Growth of local oysters at the two stations was substantially different, and the difference was

greater than the difference between "local" oysters and stocks shipped from the Chesapeake and kept at the same stations.

Although there were no obvious differences between the two local environments, the observations point to the existence of environmental conditions, which were unknown to the author but which are nevertheless, important in oyster growth.

Dr. Butler concludes from his studies that "greater differences exist in the environment at two adjacent stations (at Pensacola) than exist between stations over 700 miles apart". It should be pointed out that the statement is not necessarily true, since Dr. Butler was not comparing oysters in the Chesapeake with oysters at Pensacola. The fact that part of the oysters originated in the Chesapeake does not alter the fact that, during the eighteen months of the study, they were subjected to the conditions at Pensacola, not those in the Chesapeake. What Dr. Butler's study does show is that the origin of oysters has little to do with their growth and mortality in a new locality, within the distribution range of the species, barring injury in transportation. Also it points up the fact that perhaps undue stress has in the past been given to measurements of temperature and salinity when in fact other unknown or obscure factors are more important to oyster growth.

Robert M. Ingle, of the Appalachicola Laboratory described studies designed to measure the effect of shell dredging on fish and shellfish. The studies were carried on in Mobile Bay, at the site of the shell dredging operations to the northwest of Great Point Clear. Mr. Ingle decided from his studies that "damage to fishery animals due to dredging is frequently overrated" and pointed out that his studies led him to the same conclusions as arrived at by Robert Lunz in his studies of dredging operations in oyster producing sections of South Carolina. They also parallel those of Wilson in Texas. Ingle decided that the greatest possible distance that changes in bottom could occur was 400 yards from the operations.

Mr. A. J. Wegmann, in discussion, raised the question whether dredging operations could contribute to distribution of pollution, referring to sewage pollution from the city of Mobile. He also raised the question as to whether a combination of dredging and pollution could produce a large area (2 to 5 miles in diameter) of pollution. The concensus of opinion of the meeting seemed to be that, in the absence of any data bearing on the matter, the probability is that the two could not be linked. Mr. Wegmann also inquired as to the possibility that sewage pollution emanating from Mobile could be responsible for certain fouling of the shells of oysters in the lower Bay which was taking place at the time of the meeting. It was brought out that at the time, oyster beds in Mobile Bay were not polluted and had not been for some time. A connection between a non-existent pollution and a presently current fouling is highly problematical.

Mr. Ingle's studies pointed up the fact that wherever critical studies on dredging operations have been carried out, the results are approximately the same, namely that no measurable effects result from the operations if they are a reasonable distance from oyster beds. Mr. Ingle's conception of a safe distance is certainly conservative enough. Since silting is assumed to be the detrimental factor, it is obvious that the true problem is to determine how far are extraordinary suspensions of silt carried from the dredging operations

By "extraordinary" suspensions is meant turbidities exceeding those naturally produced by wind and rainfall (not of storm proportions). Suspensions produced by these agencies occasionally attain 500 ppm in estuaries of the Gulf. Calculations based on a round number of 100 ppm which is commonly recorded, in a water body averaging 5 feet in depth shows that a nautical square mile of water will contain about 575 tons of suspended silt. On the exceptional days when wind velocity is high and sustained there may be as much as 2875 tons of suspended silt per square mile of water of 5 feet in depth. The whole of Mobile Bay on a day with 100 ppm of turbidity would have about 288,000 tons of suspended material in the water assuming an average depth of 10 feet and an area of 250 square miles. The absurdity of becoming agitated over the comparatively minute turbidities produced by a single dredge in 250 square miles of water is apparent.

Mr. Ingle pointed out that his paper had been published as a bulletin of the Florida State Board of Conservation.

A. F. Chestnut and W. E. Fahy of the Institute of Fisheries Research presented considerable data on the vertical distribution of setting of oyster larvae. They were particularly concerned with those areas where oyster production is completely intertidal as it is in parts of Virginia, the Carolinas and Georgia.

They reviewed the literature bearing on the subject, pointing out that few papers actually measured vertical distribution of setting. Some papers measured the set on culch placed on the bottom from points above low tide to points below, which does not actually measure vertical distribution since (1) the culch was all on the bottom, and (2) no two levels were measured at the same place. In other studies observations were made at such wide intervals of time that the factor of predation obscured the true conditions of setting.

Their own studies showed that setting occurred at all levels, and was often heavy at considerable depths below low tide level, in areas where adult oysters do not survive below low tide level at all, and where production is exclusively intertidal. They pointed to drill predation as the probable most potent agency in destruction of set of oysters below low tide.

As was inevitable, it was indicated in discussion, that predation by drills could not account for all losses of spat below low tide (in South Carolina). Thus, while it seems quite probable that drill predation below low tide accounts for the greater part of destruction of spat in some areas where production is entirely intertidal, in other large areas there must be other agencies of death. Probably the most enlightening one piece of information oyster biologists could work out is the answer to this puzzle. It is so commonplace that we have even realized that it is a problem. In those areas where oyster production has had its greatest decline, losses began in deeper water, and the last to disappear were the intertidal oysters. In Australia, when the industry based on deep water production completely failed, it was revived and made vigorous by moving the operation to the intertidal flats.

Robert Lunz and Francis Beaven collaborated in a study of costs and mortality factors in transportation of very young spat from South Carolina to the upper Chesapeake. The problem of obtaining seed is often acute in the upper Chesapeake and areas north, while from South Carolina south and around the Gulf Coast there is an embarrassing richness of set. How this excess of young

oysters in the south can best be utilized in the north is a primary problem of the industry.

Lunz and Beaven experimented with wire bags of shells in taking the set of spat. These bags held ½ bushel of shell and picked up several thousand young oysters each. These are trucked to the north without removal of the shell from the bags. There was little mortality from shipment in periods up to six days. The total cost per bag, not including shipment, was 21¢. Transportation costs are 3.5¢ per bag. Three hundred thousand bushels are available annually in South Carolina, the estimate based on available shell. Transportation and planting in summer was superior in survival to that in winter. Such "shell plants" make 3 to 4 bushels of adult oysters per bushel planted, when utilized in proper Maryand waters.

There was considerable discussion during which it developed that restrictive taxation on movement of the spat out of South Carolina constituted the greatest stumbling block to utilization of southern seed in northern waters.

The most interesting factor coming out of the study was that month-old spat can be shipped with much less mortality than can one-year-old seed, and much more economically. It would appear that industry can take up from this point.

Sammy Ray, J. G. Mackin, and James Boswell studied the effect of the fungus disease caused by *Dermocystidium marinum* on weights of oysters in Louisiana using a method which established a normal relation between meat weights and shell capacity, and compared the normal relation with the relation in heavily diseased oysters. A careful mathematical analysis was prepared by R. O. Reid. In general, drastic loss of meat weights by diseased oysters was demonstrated by the authors, especially in summer months, thus explaining in part the extremely poor summer condition of most Louisiana oysters.

Discussion of this paper centered around distribution of the disease, effects of transportation into new areas, and means of transmission of the parasitic fungus cells. Known normal distribution is from Virginia to Texas, environment controls the development of the disease in any area and introduction of infective elements is not calculated to increase incidence in an area not normally subject to high incidence, and the parasites are water-borne.

A very interesting paper was presented by Don Pritchard, Director of the Chesapeake Bay Institute. Study of the movement of water in the James River estuary in Virginia showed that inflow of deep water (below ten feet) exceeds the ebb flow. This provides a mechanism by which oyster larvae produced in the lower estuary may be carried upstream to the upper reefs. Indications are that larvae tend to aggregate due to some unknown biological factor, which would enhance the chances of mass movement upstream utilizing the deep water movement. Time elements as checked by studies on the set of spat at various levels in the James estuary tend to support the hypothesis that larvae utilize the deep layers in moving upstream. Abnormal water movements, for example movements caused by flood conditions, might result in upset of normal water movement and loss of spat by being carried out of the estuary.

David H. Wallace, Director of the Oyster Institute of America, presented the closing paper of the morning session. He made several points of importance. The main thesis was that in general the oyster industry based on *Crassostrea virginica* has suffered a decline roughly of 50 per cent in fifty years.

During that time extensive research on oysters has failed to stem the downward trend in production. Mr. Wallace, in an analysis of major research fields listed those dealing with (1) set of spat, (2) effects of predators and parasites in mortality, (3) feeding and fattening (4) studies on environmental factors affecting production, and (5) selective breeding. In spite of the extensive researches, little practical utilization of results has been achieved.

Extended discussion resulted from this paper. Dr. Galtsoff ably defended the biological studies on oysters of the past century. His most telling point was that much of the failure of the great producing center of the east coast, meaning Virginia and Maryland, is caused by political factors which prevent the development of public grounds. These public grounds, very extensive in area, are the best natural producing areas. In spite of the fact that they disintegrate through lack of development, private enterprise is prohibited from using them, and is forced to utilize marginal areas. State resources are entirely inadequate for development of the State-owned grounds, so that the attitude of the State in prohibiting private development by private enterprise amounts to a dog-in-the-manger performance.

Additionally, it is obvious that researchers are handicapped further by inadequate funds for experimental studies. There is not now, and never has been, a State or Federal agency designed for oyster research which was provided with adequate funds to provide necessary equipment and personnel. Technical personnel are often supervised by non-technical personnel who insist on limiting researches to the so-called "practical" studies, which in the long run often are far from practical.

Mr. Baughman, Chief Marine Biologist, Texas Game and Fish Commission, stated it as his opinion that oyster biologists should be able to tell industry where and when to plant oysters in order to achieve a profit, and attributed a part of the decreased production to failure on the part of oyster biologists. The inference was that college-trained biologists are academic and impractical, and that a practical man could do better.

Mr. Wallace, in summarizing what could be done to relieve the situation of declining production, mentioned four things. First he advocated surveys for high-setting areas. He was evidently not thinking of the Gulf of Mexico when he mentioned this as a profitable study, since approximately all Gulf areas produce an overabundance of spat. Secondly, he advocated studies of transportation of seed, certainly an overdue study. Thirdly, he advocated studies of control of pests and predators, a field which should be highly profitable in some cases (*e.g.*, *Thais*). Fourth, he suggested removal of "political interference" in development of the industry, which field, not being of scientific nature need not be commented on here.

Mr. Wallace's paper points up the fact that we are long overdue an assessment of our position as regards research in the field of oyster production. It seems evident that certain lines of research, long since proved sterile, are still followed through sheer inertia. Other fields obviously of primary importance, are neglected. It is suggested that an assessment of position should be divided into several headings as follows:

1. Critical analysis of research of the past 75 years along the lines of
   a. Measurement of emphasis placed on various lines of research.
   b. Tracing of changing trends in research.

c. Analysis of accomplishment and delineation of areas in which we are lacking in knowledge.

2. Enumeration of the most profitable fields of research and establishment of plainly stated objectives for future research.
3. Assessment of the research facilities in terms of personnel and material and the organization of the research agencies into a co-operative organization.

Summary of Significant Economic Trends in the Gulf and Caribbean Fisheries

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In the highlights from each of the five papers presented in the Economic Session of the Gulf and Caribbean Fisheries Institute, the stress on distribution problems in fishery economics is noteworthy.

The Netherlands Antilles' fishery was discussed by a representative of the Home Government. At present, local fish production is insufficient to meet the needs of the 164,000 natives, which required importation of 4½ million pounds of fish in 1950. Economic factors inhibiting the execution of plans to develop this fishery are: lack of cold storage and other facilities, insufficient purchasing power, and the shortage of skilled labor due to the availability of oil refinery employment.

The Bureau of Economic and Business Research at the University of Florida is currently engaged in research on the effects of present marketing methods of Florida fisheries on the costs of fisheries products, on market prices, and on consumer acceptance. The objective will be to furnish members of the industry with facts relevant to the present marketing situation and the associated problems. A preliminary survey of Florida fishery operations reveals marketing practices that do not accord with modern merchandising practices. The extent to which modifications may be feasible from the firm and industry point of view cannot be ascertained until more facts about the situation have been assembled. The discussion following this paper referred to the potential danger of overlapping market studies by universities and government agencies.

In October of 1951, the Fish and Wildlife Service, in conjunction with a private market research firm, surveyed 2,473 United States households to determine their preference for fish and shellfish. These households were a representative sample of all United States households. Fifty-two questions, some with sub-parts, were asked the respondents in these households, in considerable detail, about various preferences for fish and shellfish. The relative use of the principal types of fishery products by region and in total for the United States is presented in this paper. Further information with respect to species important to the Southern region is given on such questions as species used, season and day used, likes and dislikes, with respect to various types of fishery products, etc. The paper was read by A. W. Anderson, Chief, Branch of Commercial Fisheries, U. S. Fish and Wildlife Service, who defended Mr. Stolting's findings in an animated discussion.

The paper on fish prices reviewed the relatively few studies that have been made on the factors determining the price of fish. Attempts were made to

enumerate these factors by Eunice M. Werner, William C. Herrington, and Harden F. Taylor. Miss Werner compared the interrelation of controlled and uncontrolled fish prices during World War II, and Mr. Herrington compared the interrelation of production and prices in New England, 1930-1944. Mr. Taylor compared the value of fish production and the national income, 1920-1940. The results of more recent studies on the prices of fish and the degree of correlation were presented.

The author of the paper read at the Institute meeting found that on the basis of correlation analysis, factors other than volume of catch play an important part in determining the price of fish. Significant coefficients of correlation were obtained for the average annual prices of various species of groundfish and measures of personal income. The discussion referred to specific Florida price developments, as for example, in the mullet fishery and to price relationships concerning producing and marketing areas.

The "exempt" truck is an important factor in the economical transportation of fishery products. The private truckers are exempted from the provision of the Interstate Commerce Act when transporting basic agricultural commodities, and fresh and frozen fish. Pressures are being brought to bear that would seek to remove these exemptions, or at least restrict them. The combination of pending collateral matters - litigation and legislation principally - affecting the fisheries industry, if culminating unfavorably, could well create as a final result either the increase in transportation charges or a diminution of services and/or the narrowing of marketing areas for the fisheries industry.

Summary of Caribbean and General Session

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In the discussion period following the paper by Mary Schulman on "A Suggested Reorganization of Florida Fishery Laws" several points were brought up. It was pointed out that the Gulf States Marine Fisheries Commission looks forward to the simplification of the fishery laws of all the Gulf States. In answer to questions, Miss Schulman stated that it was proposed to repeal all the general and local laws and re-enact new ones. While no checks existed in the legislature to prevent the passing of foolish laws, Mary Schulman felt that the legislature tended to follow the recommendations suggested by the several Boards; further, the only way to get power from the Boards was by legislation.

It was the general feeling that there existed too many local laws which were difficult to police and which in fact often served no useful purpose, even when controlled. It was also felt that the time could not be long delayed when a complete review and revision of all legal matters would have to occupy the attention of the several Boards and the legal officers of the state.

Following his paper, "Computed Ocean Currents in the Gulf of Mexico", Dr. D. F. Leipper was asked whether there was any chance of work on currents being extended to the southern Caribbean area. Dr. Leipper replied that much depended on first having a ship available for a year, but he himself would very much like to have the opportunity of covering the area.

Questioned whether the seasonal depletion at the west end of Cuba had

any relation to the flow of the Mississippi River, Dr. Leipper felt that the seasonal flow of the Mississippi did not affect the Gulf Stream flow. In answer to a question about the depth at which the Yucatan Current influences the Gulf of Mexico and how much goes out through the Straits, Dr. Leipper stated that the velocity is 30 m.p.h. and the still depth 1,600 miles. The Florida Straits' still depth is less than 600 miles. This cuts down the flow.

Prof. Rivas replied to several queries following his paper. He stated that it was blackfin tuna rather than bluefins which were usually encountered in August and September. It was thought unlikely that tuna seen during September were on a spawning migration, as the path of tuna is along the right edge of the Gulf Stream. The local yellowfin tuna is the species found in the Mediterranean. It was considered that tuna preferred set temperatures for breeding purposes. It was also interesting to note that tuna usually travelled in a northerly direction when the wind was blowing southerly.

It was believed that a 100 pound fish was approximately five years old. The stomachs of bluefin tuna caught are usually empty, but on one occasion a tuna had small fish in its stomach. It was felt that this was due to the refusal to feed during spawning season, as 95 per cent of the fish taken were spent and 5 per cent were very ripe.

The question of the need for trained fishery experts was discussed following Mr. Wiles' paper. It was felt that the training of fishery officers would be continued in the United Kingdom under a scheme that had been in existence since 1946, or that this training program might be shared with the F.A.O. in South America. It was emphasized that the Caribbean Islands depended to a very large extent on their fish, and any research carried out by any country or group of countries would be greatly appreciated,as these Islands needed help.

A Brief Review of the Work of the Atlantic States Marine Fisheries Commission

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Since the report of this Commission delivered here last year, the work of the Atlantic States Marine Fisheries Commission has proceeded along the lines previously established, namely, by Sections and Committees.

The North Atlantic Section at two meetings has been studying changes in minimum size of lobsters, minimum mesh sizes for haddock fishery on George's Bank, the findings of the clam and shad investigations, the results of experimental work on freezing in-the-round at sea and exploratory fishing for tuna in North Atlantic Waters with Japanese long line trawls and the development of the cooperative sardine promotion program in Maine. The Section has also considered the proposed Striped Bass Program, the need for better catch statistics, possibilities of a Fishery College in Massachusetts, problems related to the yellow tail flounder fishery and the need for renovating the Woods Hole Laboratory of the U.S. Fish & Wildlife Service.

The Middle Atlantic Section has held two meetings and two of its states, New Jersey and Delaware, have met together on the problem of Delaware Bay. The Section has considered revision of the Shad Management Act for the Delaware River already adopted by Pennsylvania; the work of the new Delaware Fishery Laboratory, the need for the adaption of minimum sizes for clams by non-producing states like Pennsylvania; the new weakfish study initiated by New York; reports of the Shad Investigation with respect to determining age from scale readings and the actual fecundity of shad in terms of total spawning effort. The latter was found to be roughly 250,000 per roe shad per season instead of 25,000 as previously believed.

The Chesapeake Bay Section has had five meetings and continued its discussions looking toward joint action by Virginia and Maryland with respect to the oysters of Potomac River. Other topics considered by the Chesapeake Section have included catch statistics, the blue crab studies of the Chesapeake Biological Laboratory and the Virginia Fisheries Laboratory, their joint soaker study, the work of the Chesapeake Bay Institute, and the reports of the Shad Investigations in the Chesepeake. All five meetings during the past year have been devoted primarily to an effort to reach agreement on the Potomac River oyster fisheries.

The South Atlantic Section which met here Monday night has held three meetings in 1952 devoted to the study of license fees and severance taxes, the possibility of a model statute along these lines, the development of the cooperative Shrimp Program which is temporarily being held up pending the publication of the reports by the Fish and Wildlife Service on past shrimp studies, the joint Federal State Cooperative Program for which the Theodore N. Gill has been put into commission and on which Georgia and Florida have both made committments with respect to man power. The Shad Program in the South Atlantic States was begun in 1952 and will be continued over the

next two years. Progress is being hampered by lack of adequate catch statistics in the past. One of the interesting developments considered by the Section has been the work of the University of Miami with respect to the carrying of shrimp in refrigerated sea water. North Carolina is interested in the striped bass problem but the other states, further south, do not appear so vitally concerned as the striped bass grow less important south of the Carolinas.

The Striped Bass Committee of the Commission brought forth an excellent report recommending a cooperative Federal State Research Program with respect to striped bass or rock fish and urged that Dingell-Johnson funds be utilized for the purpose of financing the State studies under the Joint Program. The Fish and Wildlife Service has offered to assign one or two competent men to the Federal part of the program as soon as enough states make firm committments with respect to their portions of the programs.

A special Committee on Inland Waters has been working on the problem of devising a method for controlling fishing operations by out of state votes. In managing inland waters, the problem is to work out a method that will exercise adequate control in the interest of conservation without discrimination of the character which gave rise to the decision in *Toomer v Witsell*. The special committee has come with a proposal for an amendment to the Atlantic States Marine Fisheries Compact under which the several participating states would agree to respect the Inland Waters of the other states party to the agreement. At the Annual Meeting in Boston early in September this matter was discussed at length but the various states there represented deferred judgment pending further study of the proposal.

The Eleventh Annual Meeting in Boston was the largest and most important yet held by the Commission. The Executive Committee decided that the Commission is now so well established that it will no longer be necessary for the Secretary-Treasurer to make the long trek by car each year up and down the coast, but we shall try to have more frequent Section Meetings at which I can discuss problems with the commissioners collectively instead of on an individual basis.

The Pollution Project is now practically completed and wound up except for a few details involving the disposition of equipment. It has been a productive enterprise and the State reports which were filed with the Fishery and Health officials of each state contain a mass of information which should be valuable for future reference in connection with the pollution of marine waters.

These activities, none of which is spectacular by itself, in the aggregate illustrate the methods by which understandings are reached between states, and such understandings are the vital ingredient of effective interstate cooperation in this or any other field.

Activities of the Gulf States Marine Fisheries Commission October 15, 1951-October 15, 1952

W. Dudley Gunn

Secretary-Treasurer Gulf States Marine Fisheries Commission, New Orleans, La.

The proper utilization and development of the fisheries of the Gulf of Mexico is the objective of the Gulf States Marine Fisheries Commission. In order for the Commission to accomplish its objectives, it depends upon the cooperation of the state and federal governments, industry and other sources to supply desired information. When sufficient information is available about a fishery the Commission is able to draw conclusions and make recommendations. Such recommendations are channeled through the proper state and federal authorities. If recommendations receive favorable action, avenues are opened which might well lead to better care and development of the fisheries concerned.

Since the Commission came into existence, approximately three years ago, a great many new fishery programs have been instituted and some of the few that were in existence at that time have been expanded. Essential data are now being accumulated and a foundation for many individual and badly needed studies is in sight.

All of the Gulf States are working toward the maintenance of high level oyster production through biological research and reef development. Briefly summarizing other valuable work being accomplished by the member states: Alabama is to start taxonomical work on the fin fishes in the near future and an oceanographic survey of Mobile Bay and Alabama's Mississippi Sound is a prospect. Florida has developed valuable data on the growth rates, spawning periods, sizes and other information concerning the mullet in the area from Apalachee Bay west to the Alabama line. Technological work involving refrigerated holding and transport of shrimp is another Florida project. In addition to its oyster program, Louisiana is expected to start investigations on a number of the fin fishes of commercial and sports interest. Mississippi has already undertaken a flounder program and work will soon start on the life history of the speckled trout. A survey of the water bottoms was undertaken last summer. Texas is compiling essential data on the speckled trout, redfish, drum and flounder.

The Fish and Wildlife Laboratory at Pensacola is progressing its study of the genetics of the oyster and continuing inquiry into the enemies of the oyster. In the Gulf proper, the Exploratory Commercial Fishing Section of the Fish and Wildlife Service is carrying forward programs in exploratory fishing, gear development, freezing shrimp at sea and a trash fish study. Gulf Investigations, another section of the Service, is covering the Gulf in a program of fishery biology and this in all of its ramifications, even including the chemical consistuency of the waters. An oceanographic survey is being made of the Gulf by the Texas A&M Department of Oceanography, the U.S. Navy being the program's sponsor.

Work on the life history and habits of shrimp is indicated for the coming year. Data compiled over a period of years should soon be made available by the Fish and Wildlife Service and this information is expected to indicate

what further investigations are necessary. Such work will undoubtedly be a joint state and federal project.

The current statistical program is a vast improvement over that of three years ago. The Commission hopes in the coming year to have advantage of better state landing records, included in which would be a breakdown on shrimp production by areas of catch and by species. Full cooperation of the states in the matter of improving statistical records was the subject of a resolution adopted at the third annual meeting and addressed to the proper state officials.

A program designed to bring about better conservation of the marine fisheries through educational procedure is an aim of the Commission. Due to the lack of sufficient information the program cannot become effective in the immediate future.

Consideration was given last year to the making of an oceanographic survey of the inshore waters of the Gulf. Such a program, suggested to be a joint state and federal project, has been acted upon favorably by the Commission and the Fish and Wildlife Service, and doubtless will be undertaken when funds and personnel become available.

In the past year Louisiana passed a law which allows non-resident fishermen the same rights as resident fishermen, including of course the right to pay the same licenses and taxes. Texas already had such a statute in effect. At the 1952 session of the Mississippi legislature a similar bill got on the calendar but did not come up for vote. Mississippi has a fishing agreement with both Louisiana and Alabama, the latter agreement having been consummated during the year just ending. Florida and Alabama have a shrimp fishery agreement of several years standing.

Working from a digest of the fishery laws of the several states, the Commission's attorneys and biologists met at Pensacola in July of this year and two recommendations came out of the meeting. These recommendations concerning the oyster and blue crab fisheries, were taken into consideration at the October Brownsville, Texas, meeting and will be given further study. A resolution concerning these fisheries was adopted which it is hoped will stimulate investigations in line with determining the causes for lower production where such is occurring.

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